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K. A. Zakhvatkina

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LARVAE OF BIVALVE MOLLUSKS OF THE SEVASTOPOL REGION OF THE BLACK SEA

By K. A. Zakhvatkina

Heretofore, the systematic relationships as well as the biology and ecology of bivalve larvae have been poorly known. The work of A. Borisiak (1905), on the larvae of bivalve mollusks, is of only historical interest since only four of the 20 forms described were determined to genus. Data on the reproduction of several species of bivalve mollusks, especially on spawning seasons, are given in the work of Z. A. Vinogradova (1950), but unfortunately the author does not describe the larvae. This exhausts the list of works for the Black Sea and bivalve larvae are not known at all for other seas of the Soviet Union. The excellent systematic works by Jorgensen (1946) and Rees (1950) for the Danish straits and the North Sea and also works of several other authors[1] may be added to our list only by way of guidance, since larvae in other regions of propagation may differ in morphology or more particularly in ecology. p.108

The following data indicate how great is the role of larvae of bivalve mollusks in the sea, especially during certain seasons of the year. In the bay of Sevastopol in the summer of 1953 and 1954, they were the third or fourth most abundant zooplankton forms counted in 1 m^3 of water. On 7 May and 26 September 1953 they were the most abundant forms. Their percentage of the whole biomass of organisms in 1 m^3 averaged 4-9 o/o but sometimes rose to 19 o/o. The works of V. N. Nikitin (1939) O. G. Kosiakina (1950), M. A. Dolgopol'skaya (1940), A. P. Kusmorskaia (1950) and others also show the importance of the larvae in the sea in summer and fall. At present there is great need for a key for the identification of larvae of bivalve mollusks. Our work was undertaken only as a first step in this direction and consequently I cannot claim a complete knowledge of the systematic position of larvae of bivalve mollusks of the Black Sea.

Brief Morphological Outline of the Post-Embryonic Development of Black Sea Bivalve Mollusks

Many marine bivalve mollusks have a free-swimming larva, the veliger, widely known in the literature (Davydov, 1914; Ivanov, 1945; Schmidt, 1951; Korshelt and Heider, 1936). However, for convenience in describing larvae, many authors identify two stages in the free-swimming period.

Jackson (1888) and Bernard (1896) distinguished the primitive and the definitive prodissoconch in the development of the primary shell p.109

[1]Kandler, 1926; Lebour, 1938; Loven, 1879; Miyazaki, 1935-1936; Stafford, 1912; Werner, 1939; Yoshida, 1936-1939.

stages. Later the abbreviated terms Prod. I and Prod. II were applied to designate these growth stages (Werner, 1939; Jorgensen, 1946; Rees, 1950 and others). Prod. II consists of Prod. I plus bands of growth (Werner, 1939). The shell of the adult mollusk is called the dissoconch.

In English and American literature (Stafford [Canada] 1912; Jørgensen [Denmark] 1946) the early stage of a free-swimming larva is called the "straight-hinge stage" (the shell of this stage has a hinge area appearing like a straight line). The larva becomes the veliger in a much later stage. Sometimes, in conchological literature (Miyazaki, 1935-1936), the early stage is called the "D-shaped" stage on account of the semicircular form of the shell. Werner (1939) calls attention to the fact that the terms "straight-hinge stage" and "D-shaped stage" are not identical with Prod. I, since in the latter there is a shell which is morphologically separated from Prod. II. Also, larvae retain a straight-hinge area for a long time after the beginning of the Prod. II stage.

Werner (1939) distinguishes the two stages as follows: The veliger stage extends over period of development from egg to swimming larva, the body of which is enclosed in a bivalve shell with a straight hinge area; the veliconch stage includes that period of development from the veliger to the completely formed larva at metamorphosis. Werner noted that such a division of stages is not arbitrary or artificial. They are well distinguished morphologically and ecologically. The veliger has only a planktonic way of life, while the veliconch has a partially benthonic existence. According to Werner the veliconch stage includes the stage of metamorphosis which is distinguished separately by other authors (Hagmeier, 1930; Erdmann, 1934).

In our work we use Werner's names for designating stages of the larvae, veliger and veliconch, leaving the terms Prod. I and Prod. II for the shells themselves. However, we somewhat narrowed the definition of veliger, and defined it as encompassing development from the trochophore, not from the egg as Werner did, to formation of the free-swimming larva with bivalve shell and straight hinge area. In the concept of veliconch we, like Werner, include development from veliger to the completely formed larvae ready for and undergoing metamorphosis.

Embryology of marine bivalve mollusk has been studied in sufficient detail by Hatschek (1881), Brooks (1880), Havinga (1929), Loven (1879) and others.

The majority of the Black Sea bivalve mollusks discharge their eggs freely into the water where fertilization and subsequent development occur. Eggs of <u>Cardium edule</u> and <u>Cardium exiguum</u> are enclosed in a gelatinous film and are fastened to an underwater substrate. Some mollusks, e. g. <u>Loripes lacteus</u> and <u>Syndesmya ovata</u>, form egg masses in which development of the eggs proceeds to the veliger stage. <u>Teredo navalis</u>, <u>Ostrea taurica</u> and <u>Montacuta bidentata</u> retain eggs to the veliger stage inside the maternal organism. Each species has its own term of development to the veliger stage, normally one to two days.

Veliger (Fig. 1). The veliger has a soft body and rounded shape. The organ of motion, the velum, is formed from the upper section of the trochophore. The velum is bordered by a row of cilia and bears a central cluster of cilia, the so-called parietal organ [or apical p.110
flagellum], which is homologous to the apical organ of the trochophore. In some species, e.g. in *Loripes lacteus*, the cluster of cilia is absent. The velum is drawn in by two pairs of retractile muscles. The digestive system is differentiated and consists of a pharynx, stomach with glands, central gut, frontal diverticulum and short posterior gut opening into the anal orifice on the posterior end of the body. One adductor muscle lies anteriorly. Most organs are usually white, rarely yellowish. Only the digestive diverticulum [or liver] may be colored greenish-yellow or brownish. For *Ostrea taurica* a pigmented velum has been described, but such pigmentation has not been observed for other larvae. Internally there can be seen, in several species, more or less rounded drops the nature of which is unknown. Possibly it is food substance. Usually development from egg to veliger occurs at the expense of the reserve food supply of the egg (Ivanov, 1945) and only later do the larvae begin to feed independently.

The shell of the veliger (Prod. I) is equal-valved and characteristically semicircular with a straight hinge area. Only in a very few species may there be some other form (see description of *Loripes lacteus*). The shell is completely calcified and has a conchiolin base. Only its dorsal part lacks lime and represents the primitive ligament. The shell is thin and transparent, usually not colored. Its surface has weak etchings or markings and may be chiseled or granular, alveolar or reticulate. The hinge may be expressed by a weakly thickened hinge line or it may be entirely absent. In some species teeth are well developed (*Mytilus*), but in others there are only rudiments.

As in the structure of the soft body, only a few distinguishing marks can be found in the structure of the shell of the veliger stage. Hitherto the most used characteristics in the systematics of the veliger are measurements of Prod. I. Thus, Stafford (1912) uses the varied length of the hinge area and Jorgensen (1946) uses length of Prod. I. Werner (1939), besides length and height of Prod. I, takes the ratio of the height of Prod. I to its length, and the ratio of the length of the hinge area to the length of Prod. I. The inadequacies of these characters are immediately revealed by comparing the results of different authors dealing with the same species. Although undoubtedly measurements of Prod. I are reasonably constant for the same species from a given region, we must point out that it is necessary to average sizes from a great number of measurements (at least 25) because of the variability in measurements of this Prod. I stage within the species. After a satisfactory accumulation of data for many species, the additional use of the ratios of height to length of Prod. I and length of hinge area to length of Prod. I makes it possible to distinguish veligers of different species of bivalve mollusks.

The veliconch (Fig. 2). In the veliconch stage further growth p.111
and differentiation of the soft body occurs.

The velum grows and increases with the size of the shell, as is evident in swimming larvae. The straight velum of the various species takes on a rounded or oval form.

New parts are developed in the digestive system with the transfer to independent feeding. The follicle of the crystalline style is separated from the stomach. The digestive diverticulum takes on its characteristic color and form-rounded or oval. Its color varies in different species from yellow-green to dark-brownish but in Tellina fabula it is blue-green. The posterior gut becomes longer and, characteristically for the bivalve mollusks, forms loops set far forward.

Among the new organs developed are folds of the mantle which begin to produce the material of the shell. Statocysts appear, formed by ectodermal invagination. Statocysts have a differing construction in several species. They may have an excretory duct, appearing as a thin canal, or be without an excretory duct. Inside a statocyst there may be in one case, one large statocyst, in another case, one large and several small statocysts, and in a third case only one small statocyst.

In several species eyes, appearing as dark pigmented spots, are developed between the pharynx and velum. The evolving nervous system of the veliconch consists of three pair of ganglia, the cerebral, visceral and pedal, with corresponding connections. Toward the end of the veliconch stage the gill loops and foot are formed anteriorly.. The foot, at this stage in all mollusks, has a byssus gland which is subsequently reduced in several species. The presence of the foot allows p.112 the larva to crawl and conservation of the velum enables it to swim. A posterior adductor muscle also develops, located under the alimentary canal, in contrast to the anterior adductor muscle, which is located over the alimentary canal. Protonephridii become visible and in some species towards the end of this stage siphons appear. Such is the organization of larvae ready for metamorphosis. The transfer of larvae to a benthic form of life is associated with reduction of the velum and subsequent development of internal organs.

The developing prodissoconch loses its characteristic semicircular form, taking on a new configuration. The hinge line of Prod. I by further development ceases to be straight owing to the development of the umbo. The shell is changed from flat in cross-section to more or less convex, becoming in several species almost round (Teredo). Often larvae appear asymmetrical in right and left valves (Ostrea). The differences in the shape of the Prod. I veliconchs of different species is very important. They range from rounded, transverse-oval, triangular, quadrangular, etc. The following terms have been accepted for descriptions of the forms of veliconch shells (Fig. 3, I). Length of shell is the maximum distance between anterior and posterior ends of shell, parallel to the hinge area. The height of the shell is the distance from top of the umbo to ventral region. The thickness of shell is the maximum measurement between valves. Besides this, the shoulders develop as the dorsal areas of the shell on both sides of the umbo. Opposite

the umbo is the ventral area, or the open area of the valves. Next is the anterior end bearing the velum, and the posterior end on which siphons are formed. The shell may be flat or convex (Donax and Teredo). Shoulders are of the same or different length (Montacuta and Tellina) and form a distinct angle with the umbo or are parallel to each other (Veneridae and Montacuta). The ventral area may be straight, distinctly rounded, or more or less tapered toward the end (Tellina, Pholas, Pecten). The anterior and posterior ends of the shell may be of different lengths and forms. If they are of the same length and shape, then the shell is called equilateral p.113
(Montacuta). Otherwise the shell is called non-equilateral (Mytilus). The anterior and posterior ends may be narrow or broad, elongated or shortened. Umbos are developed in the majority of the veliconchs. In one species (Montacuta) the umbo is low and broad, in another small and sharp (Pecten), in a third narrow and high (Pholas). Sometimes the umbo does not develop at all (Loripes).

To prevent distortion of the form of the shell of the veliconchs in sketches and microphotographs and to prevent errors in species determination, it is necessary to place a separate valve on a glass slide with the convex side up.

An important systematic character for larvae of bivalve mollusks is the larval hinge, or the provinculum, which is quite evident from gross examination of the interior of the opened valves. The provinculum is the thickened hinge area with the cardinal teeth which appear as separated ends of the radial ribs of the valve from which they originate (Handbook of Zoology, 1940). However, in several species there is no such secondary appearance of hinge differentiation (Loripes, Montacuta). The great variety of provinculum constructions becomes apparent with familiarity with veliconchs of a large number of species.

The scheme of organization of the hinge of the veliconch is shown in Fig. 3, II.

The provinculum is formed by distinct teeth or by tooth plates. The teeth may be rectangular or pointed (Tellina and Syndesmya), similar or dissimilar along the whole length of the provinculum (Tellina and Mytilus). They may be many or only two to four (Mactra and Pholas). Furthermore, dentition may or may not be similar on both valves. In two cases, a thick plate of few teeth is found on one valve, while cavities for the reception of these teeth are found on the other (Cardium).

In the hinge, besides the provinculum, the lateral hinge system is developed. One valve, usually the left, has a thicker projection of the shoulder than the other. Rees (1950) calls these flanges. On the right valve, the inner calcareous ridges run parrallel to the thin shoulders. In the closed shell the flanges are enclosed by the shoulder or by the ridges on the other valve.

Sometimes flanges and ridges alternate in location on the valves: one flange and ridge occur on one side, the others on the opposite valve. The ends of flanges touch the provinculum, and sometimes develop tooth-like projections which may be taken for provinculum teeth. These are lateral teeth, which belong to the lateral hinge system. Two kinds of lateral teeth, having different construction, may develop. One kind are plate teeth lamellae that cover part of the opposite valve, but do not touch the provinculum of the other valve. They have the appearance of platelets extending along the shoulder with edges diminishing till they disappear (*Montacuta*). The other type is solid and has the appearance of a tooth. In the closed valve they touch the provinculum of the other valve (*Mactra*). Lateral teeth are well seen in examination of an end view of the shell. Ridges usually converge with the provinculum and sometimes even break off. They develop no other teeth. Several species have special teeth which do not belong to the lateral system or to the p.114 provinculum. They vary in form and will be described below. The location and form of the ligament is of great value for differentiating species. In almost all groups, except for Solenacea, it is external. The ligament may occupy a central position in the hinge and then hinge differentiation is observed to be symmetrical on both sides. The ligament may be shifted forward or back of center and is correspondingly called anterior or posterior. The form of the ligament may be oval or rectangular. Its size also varies. Different construction of the provinculum, presence or absence of a lateral hinge system and variability of its construction, position of the ligament, and presence of special teeth give sufficient signs for identifying the veliconch.

The color of the shell, its sculpture and transparency, has some importance for the identification of larvae. The shell may be white, yellow or brown. Its external surface is striated by furrows or grooves of different size and sharpness. In several species along the edge of the shell are found coarse grooves called pallial lines. The shell may or may not be transparent.

A knowledge of the reproductive season of mollusks and the times their larvae occur in the plankton is also an important criterion for the identification of both veligers and veliconchs.

Key for the identification of the larvae of veliconchs of bivalve mollusks of the Sevastopol area of the Black Sea

1(2). Shell with unequal valves; left valve more convex, with higher umbo; right valve flat with low umbo (Ostreidae) .... Ostrea taurica

2(1). Shell with equal valves.

3(4). Height of shell greater than length; shell very much swollen and elongated in dorsal-ventral direction (Teredinidae) .... Teredo navalis

4(3). Height of shell less than or equal to length.

5(18). Height of shell approximately equal to the width; form of shell circular; both ends of shell short.

6(11). Shell strongly swollen and almost symmetrical.

7(8). Shell having radial striation; hinge area without teeth .... Larva B

8(7). No radial striation; hinge consisting of 2-3 large rectangular teeth (Pholadidae).

9(10). Shell regularly-rounded, both ends equal, empty valves colorless .... Pholas dactylus

10(9). Shell quadrangularly rounded; anterior shoulder forms a right angle with anterior end; empty valve yellow; most specimens have ventral articulation .... Barnea candida

11(6). Shell little swollen and with asymmetrical valves; anterior end somewhat longer than posterior.

12(15). Hinge consists of rows of irregular rectangular little teeth, equal on both valves; in large forms a mushroom-shaped special tooth is developed anteriorly on left valve (Mactracea).

13(14). Anterior and posterior ends of shell almost equal in length .... Mactra subtruncata

14(13). Anterior end of shell approximately twice as long as posterior .... Mactra corallina

15(12). Hinge of different construction (Veneridae, Petricola).

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16(17). Teeth on both valves unequal; on left valve they consist of small, barely visible teeth, for which there are corresponding grooves on the right valve .... Venus gallina

17(16). Hinge formed of two wide toothlike plates, of which one is set anteriorily on the left valve, the other posteriorly on the right .... Tapes rugatus

18(5). Height of the shell less than the length; shell somewhat elongated in the anterior-posterior direction.

19(24). Hinge areas equal; no provinculum teeth.

20(23). Shell symmetrical; shoulders equal in length and pitch; ventral areas equally rounded (Erycinidae).

21(22). Both ends wide and rounded; shoulder areas with unnoticeable transition into posterior and anterior ends of shell .... Montacuta bidentata

22(21). Shoulders forming right angles with ends of shell .... Kellia compressa

23(20). Shell with asymmetrical valves; shoulders unequal in length and pitch; ventral areas tapered toward the anterior end.................................. Loripes lacteus

24(19). Hinge with provinculum teeth.

25(26). Hinge consists of very close rectangular teeth which on right valve are arranged in an arch (Arcidae).

26(25). Hinge of another construction.

27(34). Shell oval-triangular; anterior end narrower and shorter than the posterior; hinge consists of rectangular teeth, equal in both valves; no flanges or ridges.

28(29). Form of shell triangular; ventral area strongly tapered toward the anterior end; middle part of hinge devoid of teeth (Pectinidae) .... Pecten ponticus

29(28). Form of shell oval; ventral area rounded and little tapered toward the anterior end; middle part of hinge having very small teeth (Mytilidae).

30(31). Length of shell more than height; shell dark-brown; umbo distinct .... Mytilaster lineatus

31(30). Length of shell approximately equal to height; color yellow or purple; umbos indistinct.

32(33). Hinge areas arranged in an arch; there is a sharp transition from lateral, large teeth to small, middle, scarcely visible ones; shell yellow .... Mytilis galloprovincialis

33(32). Hinge area arranged in a straight line; no noticeable transition of lateral teeth to middle teeth, which are large enough to be clearly visible; color of shell reddish-purple .... Modiola adriatica

34(27). Shell transverse or rounded-oval; hinge of different structure; flanges and ridges present.

35(42). Shell rounded-oval; both ends of approximately equal length; flanges arranged on left valve; ridges on right.

36(37). Hinge formed by a long projection on right valve; on left valve hinge area undifferentiated (Thraciidae).

37(36). Hinge of different construction.

38(41). Shell with asymmetrical valves; anterior end slightly pointed, posterior rounded; hinge on right valve laminated posteriorly with a third tooth developed anteriorly. (Cardiidae).

39(40). Provincular teeth present; on right valve there is a row of small, sharp teeth, on left valve corresponding cavities .... Cardium edule

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40(39). No provincular teeth; uniformly thin hinge plates on both valves .... Cardium sp.

41(38). Shell symmetrical; in right valve hard teeth developed on anterior end and posterior end of hinge (Alloididae).

42(35). Shell transversely-oval in form; arrangement of ridges and flanges alternating; on right valve ridge anterior, flange posterior; positions reversed in left valve.

43(52). Hinge formed of equal or unequal teeth; same in both valves.

44(47). Teeth rectangular, equal; not very many (9-13) (Tellinidae).

45(46). Under posterior shoulder there is a characteristic notch which gives the posterior end the appearance of a nose; color of shell intense brown; sculpture of the shell rough and clearly marked .... Tellina donacina

46(45). No characteristic notch in posterior dorsal area; shell colorless, minor sculpturing of shell is scarcely visible .... _Tellina fabula_

47(44). Teeth numerous and unequal.

48(49). Anterior end shorter than posterior; shell small (185 in length) and transparent .... _Gastrana fragilis_

49(48). Anterior end longer than posterior; shell large (about 250 long) and not transparent (Scrobiculariidae).

50(51). Umbos high and clearly visible .... _Syndesmya alba_

51(50). Umbos low and projecting little .... _Syndesmya ovata_

52(43). Hinge formed of wide posterior plates .... _Donax venustus_

Morphology and Biology of Larvae of Bivalve Mollusks

Family Arcidae

In the Black Sea there is one species of this family, Arca lactea L. (Milashevich, 1916), the larva of which is unknown.

According to Rees (1950) larvae of this family (Fig. 4) have a transverse-oval, almost round shell. The length of the shell slightly exceeds the height. The shells are symmetrical and equilateral. The shoulders are of equal length and a little tapered. Ventral areas are either evenly rounded or a little tapered toward the posterior area. The two ends are wide and rounded. Umbos are small and pointed. The provinculum consists of a row of numerous, very small and fairly even teeth. As viewed from the side of the umbos they appear tapered and not at all separated by clear gaps. The teeth on the right side are arranged in the form of an arch and are larger laterally and smaller in the center. There are no p.117 flanges but ridges occur on the right valve in very small larvae. The lateral hinge system consists of anterior solid teeth and posterior lamellar teeth, arranged on right valve and visible when larvae are not less than 300 μ long. There are no specialized teeth. The ligament is posterior.

Family Mytilidae

Mytilus galloprovincialis Lk.

Larvae of M. galloprovincialis are identical in structure to the larvae of the related species M. edulis L. Description of the larvae of M. edulis have been given by Loven (1879), Stafford (1912), Matthews (1913), Odhner (1914), Kändler (1926), Werner (1939), Jørgensen (1946) and Rees (1950). Some information about the larva of M. galloprovincialis is given in the work of Borisiak (1905).

Mussels discharge mature sex products freely into the water. Eggs are rosy and transparent with a diameter of 68-70 μ. Development from egg to veliger takes on the average of 30 to 32 hours.

The veliger (Fig. 5a). The semicircular shell is symmetrical and equilateral about the straight hinge area. Specimens of Prod. I measure: length, 80-148 μ, average 116 μ; height 64.8-130 μ, average 83 μ; length of hinge area 70.8-95 μ, average 82 μ; ratio of height to length of shell 0.7; ratio of length of hinge area to length of shell 0.8. The surface of Prod. I has a uniformly fine-grained or porous structure, and is easily distinguished from Prod. II, which has concentric lines of growth. The hinge area bears rudiments of teeth arranged as 3 or 4 little teeth on each side of the shell on both valves (Fig. 5 ꜟ). The larva is transparent and colorless. Structure of the soft body is typical (Fig. 5a). M. galloprovincialis specimens of Prod. I show the characteristic wide variability which has been reported for M. edulis (Jorgensen, 1946).

The veliconch (Fig. 5б). The straight hinge area of the larva may survive a long time, sometimes till the larva reaches 290 μ. Minimum measurements of fully formed veliconch taken by us from the plankton are 239.2 μ in length and 208.2 μ in height.

The shell (Fig. 6a) of the veliconch is fairly flat, oval, to oval-triangular, equivalved but not equilateral. Length of the shell is a little more than the height. The anterior end is larger and narrower than the broad posterior end. Both ends are rounded. Shoulders are almost straignt and unequal in length. The anterior shoulder is longer than the posterior. The ventral area is rounded and tapered toward the anterior region. Umbos are well developed, low and broad. Concentric lines are uniformly broad and deep, rarely widely separate. Shell color is uniformly yellow. Sometimes the margins of the shell are colored with the center remaining colorless. Borisiak (1905) recorded a bluish shade on the rims of shells. The hinge is well developed (Fig. 5?). It consists of rows of rectangular teeth that are larger laterally and smaller in the center. Anteriorly and posteriorly there are 7-8 large teeth and in the center 11-13 small teeth. The hinge area is curved in an arch with the hinge equal on both valves. A fairly large oval ligament is located posteriorly in front of the large posterior teeth. A pigmented eye-spot is characteristic of the veliconchs of M. galloprovincialis. These appear early and increase in size and become more intensely colored proportionately with growth of the veliconch. These spots lie on both sides of the anterior part of the larva between the velum and pharynx. The foot is usually well developed in larvae 250 μ long. In its base lie a pair p.119
of statocysts with numerous statoliths. The posterior adductor muscle appears in larvae 307.5 μ long and gill loops at a length of 278 μ. The digestive diverticulum is compact, transversely oval and colored yellow-green. It is more intense in large veliconchs.

Larvae ready for metamorphosis reach an average length of 348 μ and height of 304 μ. Minimum measurements of larvae, which in our cultures underwent metamorphosis, were 261 u in length and 243.6 μ in height. In larvae ready for metamorphosis the shell becomes still more triangular (Fig. 6б). Its ventral area is more strongly tapered toward the anterior end. The umbo is well developed. Lateral teeth are well developed in the hinge and their number increases (Fig. 6в). The ligament becomes larger. The color of the shell darkens (to brown) and sculpturing becomes distinct and deeper. The larva becomes attached to the walls of the vessel. However, it can swim on the surface of the water with the help of gas bubbles or attached to the surface film of the water (Nelson, 1928). This adaptation of the larvae to prolongation of planktonic way of life increases the possibility of wider dispersion of the species.

Larvae of M. galloprovincialis occur abundantly in the plankton in the second half of May and in June as well as in August and September, but larvae are found throughout the whole year in small amounts.

Modiola adriatica Lamarck

The egg measures 40 μ according to Vinogradova (1950). The veliger has not been described.

Veliconch. Larvae taken from plankton measure 270-331 μ long. The shell (Fig. 7) is oval-triangular to oval, rather flat, equivalved but not equilateral. The anterior end is longer and narrower than the posterior, which is wide and obtuse. Both ends are rounded. Shoulders are unequal and a little tapered. The anterior shoulder is longer than posterior. The ventral area is rounded and tapered toward the anterior region. Concentric lines are wide, shallow and not numerous. Living larvae are slightly transparent, and uniformly reddish-orange in color. Empty valves have a wide reddish band along the edge of the shell, but are colorless in the center of the shell. Umbos are low, wide, and distinct. The hinge (Fig. 8) consists of a row of rectangular teeth identical on both sides. p.120
In distinction to M. galloprovincialis, the hinge areas are in a straight line and are not arched. Furthermore, the middle teeth are clear and well separated from each other. They imperceptibly merge into the larger lateral teeth. Thus in M. adriatica the transition is not as sharp from central to large lateral teeth as in M. galloprovincialis. Flanges and ridges are lacking. The small oval ligament is posterior. A larva ready for metamorphosis is 371-378 μ long. Its ventral area becomes still more tapered toward the anterior end and umbos become higher.

Larvae occur through July and August but are scarce.

Mytilaster lineatus (Gmelin)

Eggs unknown.

Veliger. The shell (Fig. 9a) is semicircular and symmetrical, with the straight hinge area. Average measurements of Prod. I are as follows: length 105.4 μ; height 95.8 μ; length of hinge area 94.6 μ; ratio of height to length of shell 0.3; ratio of length of hinge area to length of shell 0.9. The shell is slightly yellowish and transparent. The hinge area is similar to that of the veliger of M. galloprovincialis, bearing rudimentary teeth.

Veliconch (Fig. 9b). Veliconchs taken from plankton attained a length of 236.0 - 287.0 μ.

The shell of the veliconch is rounded triangular, or egg-shaped, symmetrical and rather swollen, but with unequal sides. The anterior end is longer and narrower than the posterior with the posterior end wide and obtuse. The shoulders are slightly rounded and a little tapered. The anterior shoulder is longer than the posterior. Ventral areas are rounded and tapered toward the anterior end. Umbos are very low and wide, scarcely protruding above the shell. Concentric lines are wide and deep, rather often widely separated. Living larvae are dark brown and opaque becoming darker in color with age. The empty shell is bordered in light brown, its ventral area darker. The hinge is the same on both valves (Fig. 10), and arched, consisting of a row of rectangular teeth, which are small and inconspicuous in the center, but large and more visible along the edge. The small oval ligament is posterior. Flanges and ridges are undeveloped. Living larvae, like M. galloprovincialis, have a pigment spot.

Larvae near metamorphosis measured 230-312 μ long and 260-290 μ high. They have a well developed foot with statocysts, including small statoliths, three gill loops, two adductor muscles and well p.121
developed mantle. In such a larva the ventral area of the shell becomes still more sloping and the umbo is more evident, high and wide. Large lateral teeth develop strongly in the hinge while middle ones grow weakly.

Larvae of M. lineatus are separated from those of M. galloprovincialis by the smaller size of the shell and dark brown color. Also the length and height of shell in M. galloprovincialis are almost identical, while in M. lineatus length of shell exceeds the height.

Larvae of M. lineatus are abundant in plankton in July, August and early September. Individual large specimens are found up to November.

Fam. Ostreidae

Ostrea taurica Krynicki

A description of the larva of O. taurica was given by Borisiak (1905).

Black Sea oysters carry eggs to the veliger stage within the maternal body. At the time of reproduction, the valves of the female slowly open and then quickly slam shut and in this way "shoot out" veligers into the water.

Under aquarium conditions, eggs and trochophores discharged by the oysters along with the veligers were never observed to develop normally to the veliger stage. Whether this is a result of unfavorable conditions of the aquarium or happens in nature is not at all clear.

Veliger. The veliger in comparison with other mollusks is large. The semicircular shell (Fig. 11а) is equivalved with a straight hinge area but not quite equilateral. The anterior end is a little shorter than the posterior. Average measurements of Prod. I are: length, 136 μ, height 119 μ; length of hinge area 70 μ; ratio of shell height to length 0.7; ratio of length of hinge area to length of shell 0.5. The shell is transparent and colorless. The hinge area has triangular teeth, one anterior and two posterior. Anterior and posterior teeth are separated by an equal distance in each valve (Fig. 12 а). The internal arrangement of the veliger is typical (Fig. 12 б).

Veliconch (Fig. 11б,в; Fig. 12в,г). Veliconchs collected from the plankton attain a length of 270.4-322.4 μ.

The shape of the shell is irregularly rounded and not equivalved. The left valve (Fig. 11 б) is more convex with a well developed high umbo. The right valve (Fig. 11в) is flatter and has a low umbo. The shell is strongly swollen, with valves a little asymmetrical. The anterior end is a little shorter than the posterior. Both ends and the ventral area are rounded. The ratio of length to height of shell in the left valve is equal 1:1 (e.g. 304.2:304.2 μ) or the height of the shell is a little more than the length (e.g. 321.1: 304.2 μ). In the right valve the length of the shell is always more than the height (e.g. 304.2: 270.4 μ). The hinge (Fig. 12в) consists of rectangular teeth (two anterior p.123
and three posterior) separated by a smooth space. In looking at the interior of the shell there are wavy lines having the appearance of teeth in the center of the hinge. But from a dorsal view of the exterior of the valve there appear to be no teeth in the central part of the hinge. Flanges and ridges are not developed. The flat oval ligament is posterior. The living larva is colorless, has pigmented eye spots and a pigmented mantle border. The digestive diverticulum is colored yellowish-green. The empty valves are colorless. Concentric lines are sharp and fairly wide, separated by regular intervals. Borisiak (1905) noted a radial line along the edge of the shell.

A larva ready for metamorphosis measures 350-400 μ in length (Fig. 12 г). It has a well developed vermiform foot covered with cilia. The pigmented eye spot lies in the anterior part of the velum, beside the pharynx. The mantle is well developed and there are two adductor muscles.

Larvae of O. taurica occur abundantly in the plankton in June and July and in much smaller swarms in August.

Fam. Pectinidae

Pecten ponticus Bucq., Dautzb. et Dollfus

The Black Sea scallop is a functional hermaphrodite. The diameter of the dark-rose eggs is 48 μ (Vinogradova, 1950). The veliger has not been described.

Veliconch (Fig. 13). Measurements of the smallest larva taken from the plankton were 202.8 μ long and 169.0 μ high. The shape of the shell is triangular, equivalved but not equilateral. The anterior end is a little longer than the posterior and is elongated, narrow and pointed. The posterior end is wide, straight and blunt. The shoulders are indistinct and rather strongly tapered. The ventral area is strongly tapered toward the anterior end. Umbos are small and sharp. Larvae are transparent and colorless with a conspicuous eye spot. The empty valves are colorless, with fine barely visible sculpturing. The provinculum consists of a row of rectangular teeth that are not uniform in size. They are located on both sides of the ligament with three on each side. The number of teeth increases with the growth of the shell. The small oval ligament is central. Flanges and ridges are not developed (Fig. 14a).

Larvae ready for metamorphosis are 270 μ long and 283 μ high. In such larvae a dissoconch begins to grow, which forms "wings" p.124 with radial edges characteristic for *P. ponticus*. Measurements of the largest larva taken from the plankton but still having "wings" were 364 μ in length and 343.2 in height.

Larvae of *P. ponticus* occur but are scarce in the plankton during July and August.

Fam. Lucinidae

Loripes lacteus

A description of larvae of *L. lacteus* was given by Pelseneer (1926).

Adult *L. lacteus* discharge eggs in a transparent spherical mucous mass, which may be as large as a hen's egg. Inside this mass, embryos can be seen with the unaided eye. The embryos are thinly dispersed and well separated from each other by a mucous layer.

Veliger (Fig. 15a; Fig. 16a). The shell is equivalved, but not equilateral. The anterior end is wide and the posterior end narrower. The ventral area is tapered toward the posterior end. As a result, the larva is asymmetrical and a little like a parallelogram with two parallel sides formed by the straight hinge area and ventral area and the two others by the tapered posterior part of the ventral area and the dorsal anterior region which is tapered in the same direction. Average measurements of Prod. I. are: length 100 μ; height 70 μ; length of hinge area 64 μ; ratio of height to length of shell 0.7; ratio of length of hinge area to length of shell 0.6. p.125
The hinge area is straight without hinge differentiation. The shell

is transparent and colorless. The internal structure typical but the whole body (Fig. 16 *a*) is filled by coarse fat drops. The velum lacks an apical flagellum.

Veliconch (Fig. 15 *δ*; Fig. 16 *δ*). Measurements of veliconchs from plankton range from 219.7 - 236.0 μ. The shape of the veliconch differs little from that of the shell of the veliger. As the shell grows it becomes more and more asymmetrical. The shell is transverse-oval, equivalved but not equilateral. Its anterior end is wide and elongated toward the ventral area. The posterior end is short and truncated toward the ventral area. The anterior shoulder is longer than the posterior and slanted toward the anterior end. The posterior shoulder is short and only slightly oblique. The ventral area is rounded and slopes toward the posterior end. The hinge line is almost straight and only slightly convex. The umbo is not developed. Concentric lines of growth are apparent only along the edge of the shell. They are clear, numerous and fairly thick. The shell is transparent and bordered with yellow. The living larva is uniformly yellow. The provinculum (Fig. 16 *δ*) does not bear teeth. Sometimes on observing the shell from inside, the hinge area appears wavy, giving an impression of weakly developed teeth. However, teeth are not visible when looking at the shell from the side of the umbo. Ridges develop on the right side and flanges on the left. The triangular ligament is central.

Average measurements of larvae reared in culture and ready for metamorphosis reached 169 μ. These larvae have two adductor muscles, a well developed mantle, two gill loops and a foot having a statocyst with one large statolith.

Larvae of L. lacteus in Sevastopol Bay are scarce and found from June to August. At the same time in other bays of the Sevastopol area (Kasach'ev and Kamyshev) they are abundant.

Family Erycinidae

Montacuta bidentata (Montagu)

A description of this larva was given by Loven (1879), Jørgensen (1946) and Rees (1950).

Jørgensen (1946) mentioned that the description of Mysella sp. by Lebour (1938) looks more like M. bidentata than even the description given for M. bidentata. Our observations confirm this opinion of Jørgensen.

M. bidentata bear eggs inside the maternal organism to the veliger stage. p.126

Veliger. A description of this stage is given by Loven (1879). Measurements show Prod. I. to be 150 μ. Larvae are transparent, almost semicircular, approximately equilateral, with an almost straight hinge area. There is no hinge differentiation. The mantle covers the whole shell cavity forming a projection in the middle of the hinge area and thickening along the sides. The anterior adductor muscle is developed, but the posterior one is not. The velum is oval and bears a long mobile apical flagellum which branches out from the parietal plate. The velum is retracted by a pair of muscles - retractors of the velum. The digestive apparatus consists of a pharynx and a large stomach with cilia and transparent walls. The stomach is divided into two parts, a chief or a pyloric intestine, which forms a loop, and the liver, which is divided into two lobes with the left a little smaller than the right. Behind the pharynx lies the rudimentary foot.

The veliconch (Fig. 17). These are the largest larvae of the plankton. The smallest one recovered from the plankton was 233.5 μ long.

The shape of the shell of the veliconch is transverse-oval, almost right-angled, flat, equal-valved, and at first, equilateral. Both ends, anterior and posterior, are broad or blunt and almost straight or slightly rounded. The ventral area is almost straight or slightly tapered toward the posterior area. Both shoulders are slightly oblique, but equal in length. The transformation from the anterior to the posterior end of the shell is unnoticeable. With growth of the shell larvae become less equilateral and the anterior area becomes longer and wider than the posterior. The umbo is very wide and not high. The concentric lines are thin and nearly flat, barely visible. The larva is transparent and colorless. Jørgensen (1946) noticed a purple shade along the dorsal area of the shell in bright daylight. With growth of the shell the larva loses transparency and the shell becomes white. The hinge area (Fig. 18) is flat having no teeth at all. Lateral teeth are developed from both sides of the umbo only in later stages. They are located on both valves and can clearly be seen by looking at the shell from the side of the umbo. The rectangular ligament is large and central or slightly displaced forward. There are flanges on the left and ridges on the right valve on each side of the umbo.

The length of the larva ready for metamorphosis is 343.2 μ. p.127

Larvae of M. bidentata occur in the plankton as single specimens from June to November, inclusive.

Kellia compressa Milasch.[1]

Veliconch. The shape of the shell (Fig. 19) is transverse-

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[1] Larva of K. compressa described provisionally.

oval, equal-valved, flat, and equilateral. Both ends are broad and blunt, almost straight or little tapered toward the ventral region. The ventral region is rounded. Shoulders are straight and equal in length. They form almost a right angle with the ends of the shell. The larva is transparent, and colorless, with a shell of much coarser texture than *M. bidentata*. Concentric lines are thin and close set, alternating with larger and sparser grooves very clearly seen in the contour of Prod. I. The hinge is like that of *M. bidentata*.

Larvae of *K. compressa* are very rare and are found in the plankton from July to August.

Fam. Tellinidae

Tellina fabula Gronov.

A description of the veliconch of *T. fabula* appears in the work of Jørgensen (1946) and Rees (1950).

The size of egg and veliger are unknown.

Veliconch (Fig. 20). Veliconchs taken from plankton measured 219-250 μ.

The shell is oval-triangular, equal-valved, quite swollen, but not equilateral. The anterior end is longer than the posterior. It is also a little narrower than the posterior and drawn out toward the ventral area. The posterior end is broad and round. The ventral area is straight and shoulders are dissimilar. The anterior end is longer and tapered more strongly than the posterior. The umbo is very low and scarcely visible. Concentric lines are fine and numerous. The shell is opaque. The intestine of living larvae is bluish-green. p.128
The hinge (Fig. 21a) consists of a pair of similar, rectangular teeth, alike on both valves. Ridges and flanges are arranged alternately with the anterior ridge and posterior flange on the right valve and the anterior flange and posterior ridge on the left valve. The rectangular ligament is anterior. In a larva 250 μ long, special teeth develop. Anteriorly on the right valve a beak-shaped rostral process appears and on the left are two projections with an indentation between them, that receives the rostral process.

Larvae of *T. fabula* are found in the plankton singly through the entire summer and fall season.

Tellina donacina L.

Eggs and veligers are unknown.

A description of the veliconch is given by Borisiak (1905).

Veliconch (Fig. 22a). The minimum length of veliconchs found in plankton is 152.1 μ. The shell is transverse-oblong, quite swollen, equal-valved, and not equilateral. The posterior end is broader than the anterior, but both ends are wide and rounded. Shoulders are unequal in length, with the posterior a little longer than the anterior. The anterior shoulder is strongly slanted. The ventral area is slightly rounded. The umbo is narrow and high. Living larvae are brown but the empty shell is yellow. Concentric lines are numerous and clear, alternating with sparser coarse but poorly visible grooves. Conspicuous pallial lines are interrupted near the umbo. The hinge (Fig. 23a) consists of 11-12 uniform rectangular teeth, alike on both valves and separated by indentations for reception of the teeth of the opposite valve. Flanges and ridges are arranged as in all Tellinidae with the anterior flange and posterior ridge on the left valve and the posterior flange and anterior ridge on right valve. A rectangular ligament is anterior. Usually such a form p. 129
is maintained to a length of 150 μ. Larvae measuring 300 μ to 400 μ have a very characteristic form (Fig. 22б). On the posterior shoulder there is a rough, wide indentation which gives the posterior end the appearance of a bill. Concentric lines become wider and coarser and are separated by regular intervals. In the hinge, special teeth, characteristic of the Tellinidae, appear (Fig. 23б). Larvae are uniformly light brown with a reddish spot on the posterior end of the body. The maximum length of larvae taken in the plankton was 422.5 μ.

Larvae of T. donacina occur individually during the entire summer-fall season.

Gastrana fragilis

This mollusk spawns by releasing ripe sexual products free into the water. The grayish egg with a large transparent nucleus is 71.4 μ in diameter. The trochophore is formed, on the average, four hours after the appearance of the polar body and the veliger after ten hours.

Veliger (Fig. 24a). The shell is semicircular with a straight- p.130
hinge area. Average measurements of Prod. I are: length 85.0 μ, height 78.4 μ, length of hinge area 40.8 μ, ratio of height to length of shell 0.9, ratio of length of hinge area to length of shell 0.5. The hinge area is level and has no teeth. The shell is transparent and colorless.

Veliconch (Fig. 24б). The average length of the veliconch is 185.9 μ.

The shape of the shell is oval-triangular, flat, and equal-valved, but not equilateral. The anterior end is shorter than the posterior.

Both ends are broad or blunt, and rounded. Shoulders are not equal in length and incline at different angles. The anterior shoulder is shorter than the posterior. The ventral area is slightly rounded and a little tapered toward the anterior end. The umbo is very small, wide and low, and barely projecting. Larvae are transparent and colorless. Concentric lines are very fine and numerous. The provinculum (Fig. 25a) consists of fine, numerous irregular teeth that are the same on both valves. The flanges and ridges, as in Tellina, alternate in position. On the left valve, the flange is anterior, on the right valve, posterior. The position of the ridges is reversed, anterior in the left valve and posterior in the right. The rectangular ligament is small and located in the center of the hinge.

Larvae, ready for metamorphosis, measure 200 μ. The shell of young mollusks, settled and with the velum lost, reaches 388.7 μ long and has a transverse-oval shape. The posterior end of the shell is strongly extended and both ends are broad and rounded. The ventral area is rounded and tapering toward the anterior end. The umbo is very wide and high. Great changes take place in the hinge at the time of metamorphosis (Fig. 25b). Rostral processes appear anteriorly in each valve and a third tooth, fitting into the opposite cavity on the left valve, is developed on the anterior right valve. The ligament is enlarged. p.131

Larvae of G. fragilis occur abundantly in the plankton the second half of June and the beginning of August.

Fam. Scrobiculariidae

Syndesmya alba (Wood.)

Descriptions of larvae were presented by Kändler (1926), Hagmeier (1930) Jørgensen (1946) and Rees (1950).

The size of the egg is unknown.

Veliger. The length of Prod. I, according to Jørgensen (1946), varies from 100 to 116 μ.

Veliconch (Fig. 26). The lengths of veliconchs collected from the plankton were from 21?.7 to 252.5 μ. The shell is oval-rounded, very flat, and equal-valved, but not equilateral. The anterior end is longer than the posterior, both ends are broad and rounded. The ventral area is rounded. Shoulders are not the same length and are oblique. The anterior end is longer and more strongly slanted than the posterior. The umbo is narrow and high. Concentric lines are thin and numerous. The color of the shell is dirty-white and larvae are slightly transparent. The provinculum (Fig. 27 a) consists of uneven numerous multiple teeth that are identical on both valves. Flanges and ridges are arranged oppositely. The anterior ridges and posterior flanges are located on the right valve, with anterior flanges and posterior ridges on the left valve. The small rectangular ligament is central. In large larvae a special tooth, a rostral process, develops anteriorly (Fig. 27δ).

Larvae of S. alba are rare in the plankton and are found during the summer months. p.132

Abra ovata[1](Philippi)

This mollusk discharges its egg mass as a kind of thin string 3-5 cm long. The egg mass is of mucous consistency and colored dirty rose. Development from egg to the veliger stage takes place within the egg-mass. Eggs are 67-70 μ in diameter. The trochophore develops in the course of a day and the veliger is formed on the second day. On the third day, the veliger is freed from the egg mass and moves out into the water.

The veliger (Fig. 28). The shape of the shell is semicircular with a straight hinge area. Average measurements of Prod. I are: length 100 μ, height, 83 μ; length of hinge area 60 μ; ratio of height to length of shell 0.8; ratio of length of shell area to height of shell 0.6. The hinge area has no teeth. The larva is transparent and the shell colorless. The internal organization is typical.

Veliconch (Fig. 28a). The veliconch developed in culture on the 12-15th day. Minimum measurement of a fully developed veliconch was 152 μ.

The shape of the shell is oval-triangular, flat, and equalvalved, but not equilateral. The anterior end is longer than the posterior. Both ends are rounded. Shoulders are slanted but not of equal length, the anterior shoulder being a little longer than the posterior. The ventral area is a little rounded and tapered toward the posterior end. The umbo is low, wide, and not at all projected. The shell is white and transparent. Concentric lines are very thin and fine. The hinge consists of numerous uneven teeth which appear when the hinge area is still straight (Fig. 28δ). Teeth are alike on both valves. Flanges and ridges are located opposite each other (Fig. 28β) with anterior ridges and posterior flanges on the right valve, and anterior flanges and posterior ridges on the left valve. The small rectangular ligament is central. Development of special teeth was not observed.

In culture, larvae measure 200 μ when ready for metamorphosis. Larvae taken from plankton were much larger. Their average measurements were 236.6 μ, and metamorphosis took place in those at

[1]Given as Syndesmya ovata in captions for Figs. 28 and 29. Ed.

about 300 μ in length. The foot, with a pair of statocysts (each containing one large statolith), posterior adductor muscle and one gill loop developed in culture on the 21st day. Reduction of the velum of the larva maintained in culture, took place on the 25th day. We maintained a young mollusk over the course of two months and it attained 500 μ in length. p.133

The shape of the shell (Fig. 29δ) of the young mollusk is transverse-oval with a long anterior end. Both ends are wide and rounded. The ventral area is rounded. The umbo is high and narrow. Definitive teeth are developed in the hinge (Fig. 29B).

Larvae of A. ovata are numerous in the plankton in June, but single specimens were found also in July and August.

Fam. Donacidae

Donax venustus Poli var. radiata Andrz.

Eggs and veliger are unknown.

Veliconch (Fig. 30). The minimum length of veliconchs taken in plankton was 185.9 μ. The shape of the shell is rounded-oval, flat, and equal-valved, but slightly nonequilateral. The anterior end is longer than the posterior. Both ends are wide and rounded. p.135 Shoulders are almost the same length and a little tapered. The ventral area is rounded. The umbo is low and wide, projecting little. The shell is white and very transparent. Concentric lines are fine and numerous but not conspicuous. In minute larvae the hinge bears rudiments of special teeth consisting of a rostral process in front on the right valve and wide rectangular plates on the left valve (Fig. 31a). With growth of larva the hinge develops farther (Fig. 31δ-?). Ridges and flanges are located oppositely. On the right valve the ridges are anterior and the flanges posterior. In the left valve the flanges are anterior and the ridges posterior. The rectangular ligament is central.

Larvae 253.6 μ long are ready for metamorphosis. The young mollusk 338 μ long is like the adult. The shape of the shell is transverse-oval with longer anterior ends. In the anterior of the right valve a large rostral tooth develops and on the left valve a rectangular tooth develops posteriorly (Fig. 31б). The ligament gradually becomes external as flanges and ridges thicken. Measurements of the largest specimen reared in culture were 540.8 μ long and 405.6 μ high.

Larvae of D. venustus are numerous in the plankton in June.

Fam. Mactridae

Mactra subtruncata (Da Costa) var. *triangula* Renier

Larvae of *M. subtruncata* were described by Kändler (1926), Jørgensen (1946) and Rees (1950).

The diameter of the egg according to Jørgensen (1946) is 50-56 μ, and according to Vinogradova (1950), 42 μ. The length of Prod. I, according to Jørgensen (1946), is 70 μ, varying from 67 to 77 μ.

Veliconch (Fig. 32 a). The lengths of veliconchs taken from the plankton were 219.7-253.5 μ. The shell is irregularly rounded. The shell is quite swollen, equal-valved, but not equilateral. The anterior end is a little longer than the posterior. Both ends are wide and blunt, with the anterior a little narrower than the p.136 posterior. The anterior shoulder is longer and more strongly tapered than the posterior. The ventral area is rounded. The umbo is low and broad and barely visible. Living larvae have an intense yellow color. Usually a yellow tinge is concentrated along the edge of the shell in the shell cavity. The umbo is tinted with violet. Deep and wide grooves alternate with thin concentric lines. The hinge (Fig. 33a) consists of a pair of rectangular uneven teeth located on both valves. On the right valve the hinge is characterized by a posterior tooth described by Rees (1950). In larvae 250 μ long a mushroom-shaped special tooth develops on the left anterior valve, while the right valve has a corresponding recess (Fig. 33б). There are flanges and ridges. The flanges are situated on the left valve, and ridges on the right on both sides of the umbo. The triangular ligament is posterior.

Larvae 304.2 μ long are ready for metamorphosis and transformation into a dissoconch. The shell is almost round but internally it is evident that the dissoconch assumes the triangular form characteristic of the mature mollusk (Fig. 32б).

The larva of *M. subtruncata* is an abundant form in the plankton in June.

Mactra corallina (L).

The eggs and veligers are unknown.

The veliconch (Fig. 34). A description of the veliconch is given by Rees (1950). The shell is rounded-oval, quite swollen, and equal-valved, but not equilateral. The anterior end is a little longer and narrower than the posterior but both ends are rounded. The anterior shoulder is a little longer than the posterior and both ends are slightly tapered. The ventral area is rounded. Concentric lines are fine and numerous. The hinge (Fig. 35) is organized as in M. subtruncata. p.137

Larvae of M. corallina do not occur in Sevastopol Bay.

Fam. Veneridae

Meretrix rudis Poli, var. ochropicta Krynicky

Diameter of the white egg is 50.5 μ. Development from egg to trochophore occurs in the course of 18-20 hours, and the veliger develops on the third or fourth day. This agrees with the data of V. N. Nikitin and E. T. Turpaeva (1953).

Veliger (Fig. 36). The veliger is small. The shell is semicircular with a straight hinge area. Measurements of Prod. I. are: length 64-68 μ, average 66 μ; height 51-61 μ, average 56 μ; length of hinge area 54-58 μ, average 56 μ; ratio of height to length of shell 0.7; ratio of length of hinge area to length of shell 0.8. Larvae are colorless and transparent. Organization of the soft body is typical and the round velum bears an apical flagellum.

The veliconch is unknown. Vinogradova (1950) states that the shell of M. rudis measures 300 μ long but does not give a description.

Venus gallina L.

A description of the larva of V. gallina was given by Jørgensen (1946). The diameter of the egg, according to Jørgensen (1946) is 70-80 μ.

Veliger. The shell is semicircular with a straight hinge area. Measurements of Prod. I are as follows: length 102 μ, height 88.4 μ, length of hinge area 54 μ, ratio of height to length of shell 0.8, ratio of length of hinge area to average length of shell 0.5. The hinge area is smooth and without teeth. The shell is yellowish, and larvae are opaque.

Veliconch (Fig. 37). The maximum length of larvae taken from the plankton was 136.0 μ.

The shell is round, equal-valved, equilateral and quite swollen. Both ends are short, wide, and rounded. The ventral area is round. Shoulders are of equal length and angle. The umbo is high and broad. The shell is yellow. Concentric lines are thick and spaced regularly. The hinge (Fig. 38a) is not the same in structure on the two valves. In the left valve it is formed by a row of fine rudimentary teeth which look like irregular serrated lines from the interior. On the right valve p.138

there are corresponding cavities for these teeth. In larger larvae, a large hard tooth is developed on the anterior of the left valve (Fig. 38б). Flanges and ridges are located on both sides of the umbo, the former on the left valve, and the latter on the right. Anteriorly they continue almost to the center of the anterior end, but to the rear they are considerably shorter. The triangular ligament is posterior.

Larvae ready for metamorphosis are 270 μ long. Such larva (Fig. 38в) has a well developed foot with a pair of statocysts, two adductor muscles, two larval gill loops and a well developed mantle. It is dark brownish. The dissoconch is distinguished from the prodissoconch by both structure and color. Young V. gallina reared in culture from the veliger stage are 374.4 μ long after a month.

Larvae of V. gallina are abundant in the plankton in August and the beginning of September.

Tapes rugatus[1] Bacq., Dautzb. et Dollfus

These mollusks shed ripe sex products free into the water. The diameter of the white eggs is 64.6 μ. The first trochophore appears 6 hours after formation of the polar body. The majority of eggs develop to trochophore stage at the end of the first day. Veligers appear the second day.

Veliger (Fig. 39a). The shell is semicircular with a straight hinge area. Average measurements of Prod. I are as follows: length 81.6 μ, height 68.0 μ, length of hinge area 50.6 μ, ratio of height to length of shell 0.8, ratio of length p.139
of shell 0.6. The hinge area is uneven. It is broken by fine teeth that are identical on both valves (Fig. 40 a). The shell is colorless and transparent. The internal organization is typical (Fig. 40б).

Veliconch (Fig. 39б). Length of the fully formed veliconch is 219.7 μ.

The shell of the veliconch is oval-rounded, with the length of the shell a little greater than height. It is quite swollen, equal-valved, and slightly nonequilateral. The anterior end is longer and narrower than the posterior. The posterior end is wide, blunt and rounded. Shoulders are tapered almost at a right angle to the umbo. The anterior shoulder is tapered a little more than the posterior. The ventral area is regularly rounded. The umbo is low and wide. Concentric lines are deep and wide, separated by regular intervals. Living larvae are greenish-yellow. The valve cavity is yellow. Pigment is usually concentrated along

[1]Given as Tapes vulgaris in captions of Figs. 39 and 40. Ed.

the edge of the valves and the center is almost colorless. Sometimes the umbo has a lilac tint. The shell is somewhat transparent. The hinge (Fig. 40 б) is formed by two teeth with wide transverse plates. On the left valve, this plate is anterior, and goes into a corresponding cavity of the right valve. On the right valve it is posterior and goes into a corresponding cavity of the left valve. On the anterior of the right valve is a hard tooth having a cavity on the left valve. Later this tooth grows and becomes broad. There are flanges on the left valve and ridges on the right. They are not broad and are poorly developed on both sides of the umbo. The triangular ligament is posterior.

Larvae 236.6 μ long have a well developed foot (Fig. 40 ?) with a pair of statocysts but the velum is still well preserved. There are two adductor muscles, three gill loops and a well developed mantle. At a length of 300 μ larvae are ready for metamorphosis. p.140
The shape of the shell (Fig. 39 б) of young mollusks is very much like the shell of the adult mollusks.

The larva of T. rugatus is abundant in plankton the second half of July and in August. Small numbers are found until October.

Fam. Petricolidae

Petricola lithophaga (Retzies)

This mollusk discharges ripe sex products free into the water. The diameter of the white eggs is 54 μ. Trochophores develop within 20-22 hours after fertilization and the veliger on the following day.

Veliger (Fig. 41a). The shell is semicircular with a straight hinge area. Measurements of Prod. I are length 61.8-68 μ, average 64.7 μ; height 54.5-57.6, average 56.4 μ; length of hinge area 30.0-40.0μ, average 35 μ; ratio of height to length of shell 0.8; ratio of length of hinge area to length of shell 0.6. The hinge area is smooth with no teeth. The shell is white and transparent. Organization of the soft body is typical and the oval velum bears an apical flagellum.

Veliconch (Fig. 41 б). The average length of veliconchs taken from the plankton is 146.2 μ. The shape of the shell is oval-rounded, quite swollen, equal-valved, and almost equilateral. The anterior end is a little longer than the posterior. Both ends are wide and rounded. Shoulders are the same length and slant. The ventral area is round. The umbo is wide and low. The shell is pale yellow. p.142
Concentric lines are thin and close set. The internal organization of the veliconch is typical (Fig. 42). The length of a larva ready for metamorphosis is 170 μ. Larvae of P. lithophaga occur abundantly in plankton in September and small numbers are taken till October.

Fam. Cardiidae

Cardium edule (L.)

A description of the larvae of C. edule was presented by Borisiak (1905), Lebour (1938), Jorgensen (1946) and Rees (1950).

The mollusks discharge their eggs, which are fastened to underwater objects with the aid of a thick gelatinous capsule in which they are enclosed. Diameter of the egg is 70 μ, with the gelatinous capsule 170 μ. Development from egg to veliger takes place inside the gelatinous capsule. The trochophore is formed after 30-40 hours from time of fertilization and the veliger on the second or third day.

Veliger (Fig. 43a). The shell is semicircular, with a straight hinge area. Measurements of Prod. I are: length 85-90 μ, average 87.5 μ; height 71-78 μ, average 74.5 μ; length of hinge area 48-58 μ; average 52.5 μ; ratio of height to length of shell 0.8; ratio of length of hinge area to length of shell 0.5. The hinge area is smooth and without teeth. Larvae are white and transparent and the internal structure is typical.

Veliconch (Fig. 43 б). Veliconchs taken from plankton measured 152.1-236.6 μ.

The shell is triangular-oval, quite swollen, equal-valved, and almost equilateral. Both ends are rather wide and rounded. The anterior end is slightly elongated and pointed. Shoulders are identical, short and strongly tapered, which gives the top part of the shell the appearance of a triangle. The ventral area is rounded. The umbo small, low and wide. Larvae are somewhat convex, especially in the vicinity of the umbo. The shell has no definite sculpture, except for clear pallial lines, which are interrupted near the umbo. The living larva is somewhat transparent. The shell cavity is colorless. The hinge is unlike on the two valves (Fig. 44 a). On the right valve there is a row of very fine and uneven teeth, with corresponding cavities on the left valve. On the anterior of the right valve a hard tooth is formed and posteriorly on the same valve, a lamellar tooth. Flanges and ridges are well developed, the former are located on the left valve and the latter on the right. The ligament is posterior.

Larvae ready for metamorphosis measure 250-300 μ. The shape of such a shell changes (Fig. 43в) somewhat. It is round-oval, equal-valved and rather swollen with both ends and the ventral area regularly rounded. Shoulders are large and slightly tapered. They almost form a right angle with the ends of the shell. The umbo is fairly high and wide. A larva becomes less transparent and takes on a white color. In the hinge (Fig. 44 б) there is a well developed hard, plate tooth on the right valve. Flanges and ridges become wider. Such a larva has a vermiform foot with a pair of statocysts enclosing one large statolith, two adductor muscles, two larval gill loops and a well developed mantle.

Young C. edule (Fig. 43 ?) are easily distinguished by the dissoconch which bears a radial rib characteristic for the species. The shell is oval-transverse with wide anterior and posterior ends p.143
and a slightly rounded ventral area. In the hinge differentiated teeth begin to develop (Fig. 44 б). A larva 338 μ long and 304 μ high has three larval gill loops and a larva 422.5 μ long and 354.9 μ high has four larval gill loops and a well developed siphon (Fig. 44b). The largest larva reared in culture was 490.1 μ long and 354.9 μ high.

Larvae of C. edule are numerous in plankton the second half of May and the beginning of June; however, single specimens are taken all through the summer.

Cardium exiguum Gmelin

Development of C. exiguum was studied by Loven (1879).

Eggs are enclosed in a gelatinous capsule. The diameter of eggs is 64 μ. Development from egg to trochophore takes place in the course of 30-48 hours. The veliger is formed on the second or third day and is liberated from the capsule on the fourth day.

Veliger. The shell is semicircular with a straight hinge area. Average measurements of Prod. I. are: length 91.8 μ, height 81.6 μ, length of hinge area 63 μ, ratio of height to length of shell 0.8, ratio of length of hinge area to length of hinge 0.6. The hinge area is straight and without teeth. The larva is colorless and transparent. Internal organization is typical.

The veliconch is unknown.

Veligers of C. exiguum are numerous in plankton during the second half of May.

Cardium sp. p.144

The veliger is unknown.

Veliconch (Fig. 45). The average length of veliconchs from plankton is 236.6 μ. The shell is irregularly rounded and is equalvalved. Its anterior end is strongly tapered into a little bill. The posterior end is wide and rounded. Shoulders are of equal length and a little slanted. The ventral area is regularly rounded. In the anterior shoulder the umbo has the appearance of a wide platform when viewed from the side. Concentric lines are wide but not very clear. Pallial lines are very evident. The shell is transparent and colorless. The larva is very like the larva of C. edule but is usually larger, flatter and well distinguished by the organization of the hinge. The hinge (Fig. 46) has no teeth. On both valves hinge surfaces are narrow. On the right valve a hard tooth develops anteriorly and a plate tooth posteriorly. Flanges and ridges are located as in Cardium. The rectangular ligament is posterior.

Larvae of Cardium sp. are rare, occurring in the plankton in June.

Fam. Pholadidae p.145

Pholas dactylis L.

Larvae of P. dactylis were described by Kandler (1926) and Rees (1950).

The Black Sea pholads discharge mature sex products free into the water. The diameter of the white transparent egg is 50 μ.

Veliconch (Fig. 47 a). The larva is easily recognized when the shell is more than 180 μ. The shell is round, swollen, equalvalved, but not equilateral. All areas are regularly rounded and pass inconspicuously from one to another. Larvae are very convex. The umbo is well developed, high but not broad. The shell is ornamented with rare weak but wide concentric lines. Pallial lines are interrupted near the umbo. Living larvae are yellow with a greenish liver and are rather transparent. The valve cavity is colorless. The hinge (Fig. 48a) has the following organization. The right valve bears two teeth, one of which is anterior, rectangular and narrow. The other is central, and transversely lengthened almost to three times longer than the anterior tooth. The teeth are separated by cavities for the teeth of the left valve. The left valve has two identical rectangular narrow teeth (anterior and posterior) separated by a narrow cavity for the reception of the central tooth of the right valve. Also there is a front cavity for the anterior tooth of the right valve. All teeth are strong and very evident when the shell is examined from the interior. The ligament is posterior, rectangular and large. Flanges and ridges are well developed and located on both sides of the umbo. Flanges are on the left valve, and ridges on the right. As the shell grows the teeth become stronger as a result of ventral growth. The posterior tooth of the left valve loses its rectangular form and becomes conic (Fig. 48 б, в).

Larvae 300-330 μ long are near metamorphosis and have a shell irregularly rounded. They are a little longer in the anterior-posterior direction than in the dorsal-ventral. The shell is as if flattened in a dorsal-ventral direction (Fig. 47б). The larvae become strongly convex. Measurements of the largest larvae found in the plankton were 335 μ. The size of larvae ready for metamorphosis is unknown.

A muscular apophysis (myophore) is developed in young P. dactylis about 1 mm long which projects from the umbo cavity (Bernard, 1895). Kandler (1926) gives the following description of the development of the internal structure of the larva near metamorphosis. The larva has a velum and wedge-shaped foot with a pair of statocysts surrounding one large statolith. The round compact liver is green. The larva has two adductor muscles and folded mantle. Larval gill loops emerge. On the posterior end of the body are formed siphons which are extended and grow together. p.146

The larvae of P. dactylis are numerous in plankton in June and small numbers occur in July.

Barnea candida (L.) var. pontica Mil.

Descriptions of the larvae were given by Bouchard-Chantereaux (1879), Pelseneer (1926), Jorgensen (1946) and Rees (1950).

Bouchard-Chantereaux (1879) noted that development from egg to veliger in B. candida took place inside the body of the mother. According to Pelseneer (1926) the swimming trochophore is formed after 24 hours, and final veliger after 30 hours. The size of the egg and veliger are unknown.

Veliconch (Fig. 49а). The length of the smallest size from the plankton was 152 μ.

The shell is round and equal-valved but not equilateral. The anterior end is slightly pointed and forms almost a right angle with the anterior shoulder. The posterior end and ventral area are regularly rounded. Larvae are convex. The umbo is narrow and high. The living larva is a light rose color. The shell cavity is yellow. As the shell grows the larva takes on a rounded-quadrangular form (Fig. 49б). The umbo is strongly crowned. The color of the shell becomes more intense, a dark brownish. According to Rees (1950), the larva is colorless. The shell is decorated with slightly projecting and fairly rare concentric lines. The shell is convex. Such larvae are 300-330 μ long.

The provinculum is similar to that of P. dactylis. As seen by comparison of Figures 48 and 50 differences between them are negligible. The right valve bears two teeth (the middle one p.147
broad and the anterior narrow) separated by cavities for the

teeth of the left valve. In the left valve are two identical narrow rectangular teeth that are separated by a wide cavity for the central tooth of the right valve. The anterior part of the left valve has a cavity for the anterior tooth of the right valve. The ligament is posterior. Large rectangular flanges and ridges are located on both sides of the umbo. The flanges are on the left valve and the ridges on the right. With growth of the shell the teeth become strong as a result of their ventral growth, while the posterior tooth of the left valve, as in Pholas, becomes conic.

Larvae on attaining the length of 300 μ develop a rectangular tooth on the ventral area of the right valve and on the left valve a corresponding cavity for it. These are well seen on examining the shell from the ventral side (Fig. 51). If the p.148
shell is examined inside this joint, there appears to be a small round eye spot on the ventral area of the shell (Fig. 52). Similar teeth are described by Werner (1939) for Zirphaea crispata. Their function is unknown.

Maximum size of larvae reared by us was 304 μ long. Length of larvae ready for metamorphosis is 330-370 μ (Jorgensen, 1946).

Larvae of B. candida are numerous in plankton from the end of July to September. Single specimens are found up to December.

Fam. Alloididae

Corbulomya maeotica Mil.

In the Black Sea this family is represented by Corbulomya maeotica Mil., the larva of which is unknown.

A description of the larvae of this family was given by Rees (1950).

The shell is equal-valved (Fig. 53). The provinculum (Fig. 54) consists of a row of thin teeth, like the teeth of Cardium. A very distinct tooth is located behind the ligament on the left valve and is adjacent to the cavity which receives the posterior hard tooth of the right valve. On the right valve one hard tooth is located in front of the provinculum and another behind the provinculum. Flanges on the left valve and ridges on the right occur on both sides of the umbo. The ligament is posterior.

Fam. Teredenidae

Teredo navalis L.

The larvae of T. navalis were described by Jorgensen (1946).

The Black Sea borers bear eggs to the veliger stage inside the maternal organism. The diameter of the eggs, according to Grave (1928) is 50-61 μ; according to Jorgensen (1946) it is 55-60 μ. According to Grave (1928), eggs carried inside the maternal organism are released after two to three weeks. The period of the free-swimming larvae, after release from the maternal organism, extends on the average for two weeks before setting.

Veliger (Fig. 55 a). The shell of the veliger, upon release from the maternal organism, is semicircular with a straight hinge area. Length of Prod. I, according to Jorgensen, is from 65 to 80 μ and averages 72 μ. This author noted that the size of Prod. I veligers from one female differs only slightly from that of the veligers from another female. The hinge of the veliger consists of two large rectangular lateral cardinal teeth on the right valve with several central teeth.

Veliconch (Fig. 55б). The larva of Teredo grows more in height than in length. In the fully formed veliconch the length of the shell is less than its height. The maximum, fully formed veliconch taken from the plankton, was 182.7 μ long and 200.1 μ high. The shell is drop-like, round-oval, with the shell elongated in the dorsal-ventral direction. The shell is equal-valved and equilateral and very strongly swollen (Fig. 55в). Both ends are very broad, but short and rounded. The shoulders are short p.149
and rounded. The shoulders are short and the ventral area round. Color of the shell is light-brown in younger larvae and dark-brown in older larvae. The umbo is reddish. The larva is opaque. The thick and wide concentric lines alternate with finer ones. Pallial lines are located along the edge of the valve. The hinge (Fig. 56) is formed of large rectangular teeth. On the left valve are two rectangular teeth with cavities along the middle and along the edges of the teeth for reception of teeth of the opposite valve. On the right valve are three teeth of which the center is somewhat wider than the lateral ones. The teeth are separated by corresponding cavities. The flanges are located on the left valve and the ridges on the right. The rectangular ligament is posterior. The larvae ready for metamorphosis have an average length of 270 μ and height of 300 μ. Jorgensen (1946) reports a much smaller size of larvae ready for metamorphosis (200 μ long).

Larvae of T. navalis are numerous in the plankton through the whole summer, from the end of June to September, but occur p.150
in small numbers up to December.

Fam. Thraciidae

Thracia papyracea (Poli)

In the Black Sea there is one species of this family, Thracia papyracea (Poli), which is rarely found (Milashevich, 1916). The larva is unknown.

A description of the larvae of species of this family was provided by Rees (1950).

The shell is not equilateral, the anterior end being narrower than the wider posterior. The provinculum (Fig. 57) is formed by a long projection on the right valve, and by a smooth hinge area on the left valve. There are no lateral teeth. Flanges are located on the left valve and ridges on the right on both sides of the umbo. The ligament is posterior. Rees describes the larva of Thracia and gives a photograph of its organization (Fig. 58). The right and left valves of the larva are somewhat different in that the right umbo projects strongly left. The shell is colorless. Concentric and pallial lines are weak.

Larvae B

On Sept. 2 and Oct. 8, 1953 two specimens of larvae were taken from the plankton. The systematic position of neither could be determined even to family.

One specimen was 304.2 μ long and 304.2 μ high; the second was 332.8 μ long and 332.8 μ high.

The shell (Fig. 59a) is not regularly-rounded, but is equal-valved and very strongly swollen and almost equilateral. One p.151
end is narrower than the other. Both ends are wide, short and blunt. The ventral area is regularly rounded. On looking at the shell from the inside the shape is a rounded quadrangle. The umbo is high and wide, and very conspicuous. The shell is striated by numerous clear radial lines. Concentric lines are rare and barely visible. The provinculum (Fig. 59 δ) has no teeth although it is not smooth, as if it might have rudimentary teeth. The ligament is large, rounded and central. There are flanges and ridges.

Borisiak (1905) described a larva with a similar rounded shell as form "O". He notes that this form is the largest in the plankton - 350 μ. But this description differs somewhat from ours: "Shell is flat, irregularly triangular-round, oblique, with wide umbo not projecting from the hinge area" (p.157). His larva had two unequal adductor muscles, was transparent and had coarse radial structure. Whether our larva B and Borisiak's larva "O" are the same species or whether they are two different species of the same family, it is hard to say, just as it is to determine the systematic position of larva B.

Literature

Borisiak, A. [Pelecypoda of the Black Sea plankton.] Izv. Akad. Nauk, seria 5, 1905, T.22.

Vinogradova, Z.A. [Materials on the biology of mollusks of the Black Sea.] Tr. Karadag. Biol. Stantsii 1950, Vyp. 9.

Davydov, N.N. [Course of invertebrate embryology.] M., 1914.

Dolgopol'skaia, M.A. [Zooplankton of the Black Sea in the vicinity of Karadaga.] Tr. Karadag. Biol. Stantsii 1940, Vyp. 6.

Ivanov, P.P. [General and comparative embryology.] 2d ed. M. 1945.

Kosiakina, O.G. [Quantitative study of the zooplankton of Novorossisk bay.] Tr. Novoross. Biol. Stantsii 1940, t. 2, Vyp. 3.

Kusmorskaia, A.P. [On the zooplankton of the Black Sea.] Tr. AzCherHIRO, 1950, Vyp. 14.

Milashevich, K.O. [Mollusks of the Black and Azov seas.] Fauna Rossii. 1916.

Nikitin, V.N. [Plankton of Batumi Bay and its annual quantitative fluctuation.] Sb., Posviashch. Nauchn. Deiatel'nosti N.M. Knipovicha (1885-1939). M. 1939.

Nikitin, V.N. and E.P. Turpaeva. [On the question of possibility of setting in Azov Sea of Black Sea animals of Black Sea benthos.] Dokl. AN SSSR, 1953, t. 90, No. 5.

[Handbook for zoology,] T. 2, Izd-vo AN SSSR, 1940.

Shmidt, G.A. [Embryology of animals,]ch. I, 1951. p.152

Bernard F. Premiere note sur le development et la morphologie de la coquille chez les Lamellibranches (Heterodontes). Bull. Soc. Geol. France 1895, t. 23.

Bouchard-Chantereaux. Observations sur divers Mollusques marins du Boulennais. J. de conch., Paris, 1879, t.27.

Brooks, W.K. The development of the American oyster. Stud. biol. lab. Johns Hopkins Univ., 1880, v. 4.

Erdmann, W. Untersuchungen über die Lebensgeschichte der Auster. 5. Über die Entwicklung und die Anatomie der "ansätzreifen" Larven von Ostrea edulis mit Bemerkungen über die Lebensgeschichte der Auster. Wiss. Meeresunt., Abt. Helgoland, 1934, Bd. 19, No. 7.

Grave, B.H. Natural history of the shipworm Teredo navalis. Biol. Bull. 1928, v. 55.

Hagmeier, A. Die Züchtung verschiedener wirbelloseer Meerestiere Abderhalden. Handb. d. biol. Arbeitsmethoden, 1930, Abt. 9, T. 5.

Hatschek, B. Entwicklungsgeschichte von Teredo. Arb. zool. Inst., Bd. 3, Wien, 1881.

Havinga, B. Krebse und Weichtieres. Handb. d. Seet Nordeuropas, 1929, Bd. 3, H. 2.

Jackson, R.T. The development of the oyster with remarks on allied genera. Proc. Boston Soc. Nat. Hist., 1888, v. 23.

Jorgensen, C.B. Reproduction and larval development of Danish marine bottom invertebrates. 9. Lamellibranchia. Medd. Komm. Danmarks Fisk. Havunders, ser. Plankton, 1946, v. 4, no. 1.

Kändler, R. Muschellarven aus dem Helgolander Plankton. Bestimmung ihrer Artzugehörigkeit durch Aufzucht, Wiss. Meeresunt., N.F. Abt. Helgoland, 1926, v. 16, No. 5.

Korshelt u. Heider. Vergleichende Entwichlungsgeschichte. Bd. 2. 1936.

Lebour, M.V. Notes on the breeding of some Lamellibranchs from Plymouth and their larvae. J. Mar. Biol. Assoc., 1938, v. 23, No. 1.

Loven, S. Beiträge zur Kenntnis der Entwicklung der Mollusca Acephala Lamellibranchiata. Aus den Abhandlungen der K. Schwedischen Akad. der Wiss. für das Jahr 1848 im Auszuge übersetzt. Stockholm, 1879.

Matthews, A. Notes on the development of Mytilus edulis and Alcyonium digitatum in Plymouth laboratory. J. Mar. Biol. Assoc. 1910-1913, v. 9.

Miyazaki, J. On the development of some marine bivalves with special reference to the shelled larvae. I, II. J. Imp. Fish. Inst., 1935-1936, v. 31, No. 1,2.

Nelson, T.C. Pelagic dissoconchs of the common mussel, M. edulis, with observations on the behavior of the larvae of allied genera. Biol. Bull., 1928, v. 55.

Odhner, N.H. Notizen über die Fauna der Adria bei Rovigno. Beiträge zur Kenntniss der marinen Molluskenfauna von Rovigno in Istrien. Zool. Anz., 1914, Bd. 94, No. 4.

Pelseneer, P. Notes d'embryologie malacologique. Ponte et developpement de Cyprea europaea, Triforis perversa et Lucina lactea. Bull. Sci. France Belgique, 1926, t. 60.

Rees, C.B. The identification and classification of lamellibranch larvae. Hull. Bull. Mar. Ecol., 1950, v. 3, No. 19.

Stafford, J. On the recognition of bivalve larvae in plankton collections. Contr. Canad. Biol., 1912.

Werner, B. Uber die Entwicklung und Artunterscheidung von Muschellarven des Nordseeplanktons unter besonderer Berücksichtigung der Schalenentwicklung. Zool. Jahrb. Abt. Anat., 1939, Bd. 66, Hft. 1.

Yoshida, H. On the pelagic larvae and young Mytilus crassitesta Lischke. Venus, 1936, v. 6. No. 1.

Yoshida, H. On the pelagic larvae and young of Brachidontes senhausi (Reeve). Venus, 1937, v. 7.

Yoshida, H. Notes on the veligers and young shells of Solen gouldi Conrad. Venus, 1939, v. 9.

CAPTIONS OF FIGURES

Fig. 1. Diagram of the body structure of the veliger: ПК - anterior end; ЗК - posterior end; 1- velum; 2 - parietal organ; 3 - apical flagellum; 4 - cilia of the velum; 5 - pharynx; 6 - digestive diverticulum [or liver] ; 7 - retracting muscles of the velum; 8 - rear gut; 9 - stomach; 10 - embryonic mantle; 11 - anterior adductor muscle.

Fig. 2. Diagram of the body structure of the veliconch: ПК - anterior end; ЗК - posterior end; 1 - shell; 2 - umbo; 3 - stomach; 4 - anterior adductor muscle; 5 - posterior gut; 6 - velum; 7 - digestive diverticulum; 8 - edge of mantle; 9 - pharynx; 10 - foot; 11 - gill loops; 12 - pigmented eyespot; 13 - statocyst; 14 - posterior adductor muscle; 15 - anal orifice.

Fig. 3. Diagram of organization of the veliconch shell.
I. Shell (exterior view): ПК - anterior end; ЗК - posterior end; 1 - umbo; 2 - anterior shoulder; 3 - prodissoconch I; 4 - prodissoconch II; 5 - dissoconch; 6 - peritoneal region; 7 - posterior shoulder: a - breadth, б - length.

II. Hinge of larva: ПК - anterior end; ЗК - posterior end; ПС - right valve; ЛС - left valve; 1 - crest; 2 - hinge plate; 3 - hinge area; 4 - notches for teeth; 5 - rostral process specialized tooth ; 6 - umbo; 7 - teeth; 8 - ligament; 9 - laminar tooth; 10 - hard tooth; 11 - provinculum; 12 - flange.

Fig. 4. Order Arcacea (after Rees, 1950). Left - veliconchs; right - hinges of veliconchs.

Fig. 5. *Mytilus galloprovincialis*: a - internal structure of the veliger; б - hinge of veliger; в - internal structure of the veliconch; г - hinge of the veliconch.

Fig. 6. *Mytilus galloprovincialis*. a - right valve of the veliconch; б - left valve of the young; в - hinge of the young.

Fig. 7. *Modiola adriatica*: right valve of the veliconch.

Fig. 8. *Modiola adriatica*: hinge of the veliconch.

Fig. 9. *Mytilaster lineatus*: a - veliger; б - right valve of the veliconch.

Fig. 10. *Mytilaster lineatus*: hinge of the veliconch.

Fig. 11. *Ostrea taurica*: a - left valve of the veliger; б - left valve of the veliconch; в - ri ht valve of the veliconch.

Fig. 12. *Ostrea taurica*. a - hinge of the veliger; б - internal structure of the veliger; в - hinge of the veliconch; г - internal structure of the veliconch.

Fig. 13. *Pecten ponticus*: left valve of the veliconch.

Fig. 14. *Pecten ponticus*: a - hinge of the veliconch; б - right valve of the veliconch.

Fig. 15. *Loripes lacteus*: a - veliger; б - left valve of the veliconch.

Fig. 16. *Loripes lacteus*: a - internal structure of the veliger; б - hinge of the veliconch.

Fig. 17. *Montacuta bidentata*: right valve of the veliconch.

Fig. 18. *Montacuta bidentata*: hinge of the veliconch.

Fig. 19. *Kellia compressa*: right valve of the veliconch.

Fig. 20. *Tellina fabula*: left valve of the veliconch.

Fig. 21. *Tellina fabula*: a - hinge of veliconch; б - hinge of veliconch ready for metamorphosis.

Fig. 22. *Tellina donacina*: a - left valve of the veliconch; б - left valve of veliconch ready for metamorphosis.

Fig. 23. *Tellina donacina*: a - hinge of veliconch; б - hinge of veliconch ready for metamorphosis.

Fig. 24. *Gastrana fragilis*: a - veliger; б - right valve of veliconch.

Fig. 25. *Gastrana fragilis*: a - hinge of veliconch; б - hinge of young.

Fig. 26. *Syndesmya alba*: left valve of veliconch.

Fig. 27. *Syndesmya alba*: hinge of veliconch: a - provinculum; б - development of rostral process.

Fig. 28. *Syndesmya Abra? ovata*: a - veliger; б - straight hinge region of the larval shell with developed teeth; в - arrangement of flanges and ridges of the veliconch.

Fig. 29. *Syndesmya ovata*: a - veliconch; δ - young; β - development of definitive teeth.

Fig. 30. *Donax venustris* var. *radiata*: right valve of the veliconch.

Fig. 31. *Donax venustris* var. *radiata*: a, δ, β, γ - successive stages in the development of the hinge of the veliconch; ∂ - hinge of the young.

Fig. 32. *Mactra subtruncata* var. *triangula*: a - left valve of the veliconch; δ - left valve of the young.

Fig. 33. *Mactra subtruncata* var. *triangula*: a - hinge of the veliconch; δ - hinge of veliconch ready for metamorphosis.

Fig. 34. Veliconch of *Mactra corallina* (after Rees, 1950).

Fig. 35. Hinges of veliconchs of Mactracea (after Rees, 1950).

Fig. 36. *Meretrix rudis* var. *ochropicta*. Veligers.

Fig. 37. *Venus gallina*. Left valve of the veliconch.

Fig. 38. *Venus gallina*: a - hinge of the veliconch; δ - hinge of veliconch ready for metamorphosis; β - internal structure of the veliconch.

Fig. 39. *Tapes vulgaris rugatus*? : a - veliger; δ - right valve of veliconch; β - young.

Fig. 40. *Tapes vulgaris rugatus*? : a - hinge of veliger; δ - internal structure of the veliger; β - hinge of the veliconch; γ - internal structure of the veliconch.

Fig. 41. *Petricola lithophaga*: a - veliger; δ - left valve of the veliconch.

Fig. 42. *Petricola litophaga*: internal structure of the veliconch.

Fig. 43. *Cardium edule*: a - veliger; δ - right valve of the veliconch; β - right valve of a veliconch ready for metamorphosis; γ - young.

Fig. 44. *Cardium edule*: a - hinge of the veliconch; δ - hinge of veliconch ready for metamorphosis; β - internal structure of the young; γ - hinge of the young.

Fig. 45. *Cardium* sp. Right valve of the veliconch.

Fig. 46. Cardium sp. Hinge of the veliconch.

Fig. 47. Pholas dactylus: a - right valve of the veliconch; б - right valve of a veliconch ready for metamorphosis.

Fig. 48. Pholas dactylus: a, б - development of hinges of the veliconch; в - hinge of a veliconch ready for metamorphosis.

Fig. 49. Barnea candida var. pontica: a, б - right valves of veliconchs at different ages.

Fig. 50. Barnea candida var. pontica: a, б - development of the hinge of veliconch; в - hinge of a veliconch ready for metamorphosis.

Fig. 51. Barnea candida var. candida. Hinged joint of the veliconch (seen from ventral area).

Fig. 52. Barnea candida. Hinged joint of the veliconch (seen from right valve).

Fig. 53. Family Alloididae. Veliconchs (after Rees, 1950).

Fig. 54. Family Alloididae. Hinges of veliconchs (after Rees, 1950).

Fig. 55. Teredo navalis: a - veliger; б - right valve of a veliconch; в - veliconch.

Fig. 56. Teredo navalis. Hinge of a veliconch.

Fig. 57. Family Thraciidae. Hinges of veliconchs (after Rees, 1950).

Fig. 58. Family Thraciidae. Veliconchs (after Rees, 1950).

Fig. 59. Larvae B: a - veliconch; б - hinge of veliconch.

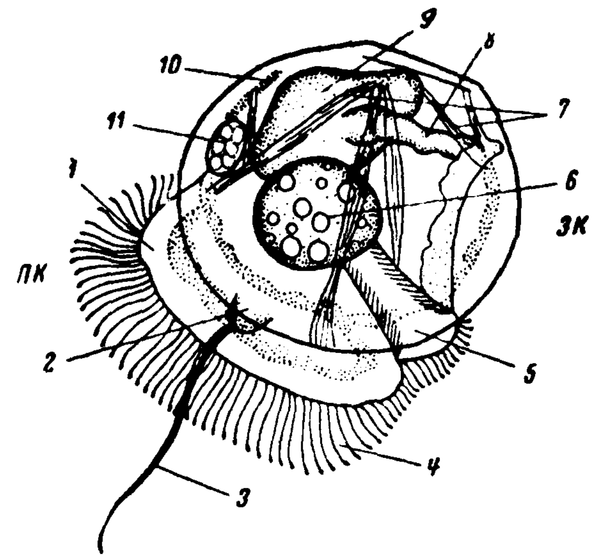
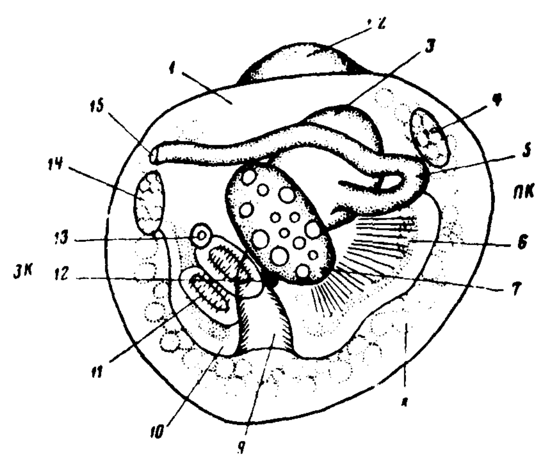


Рис. 1.



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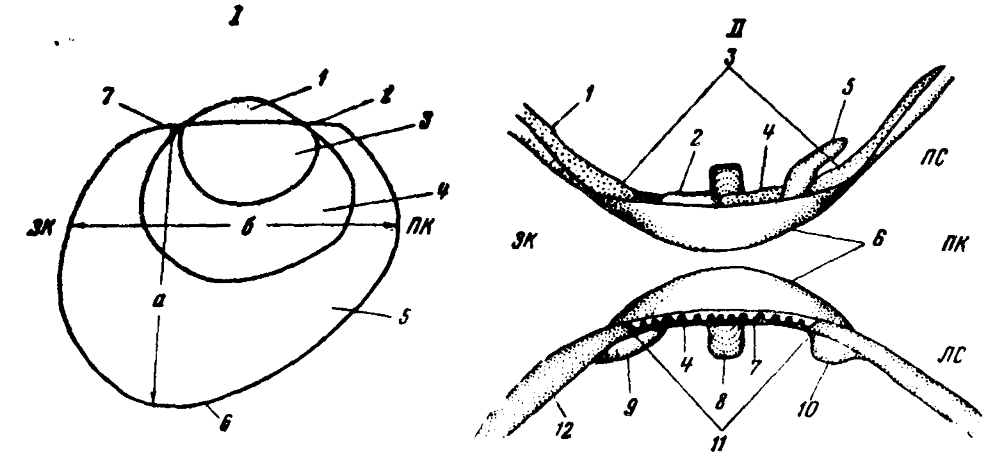
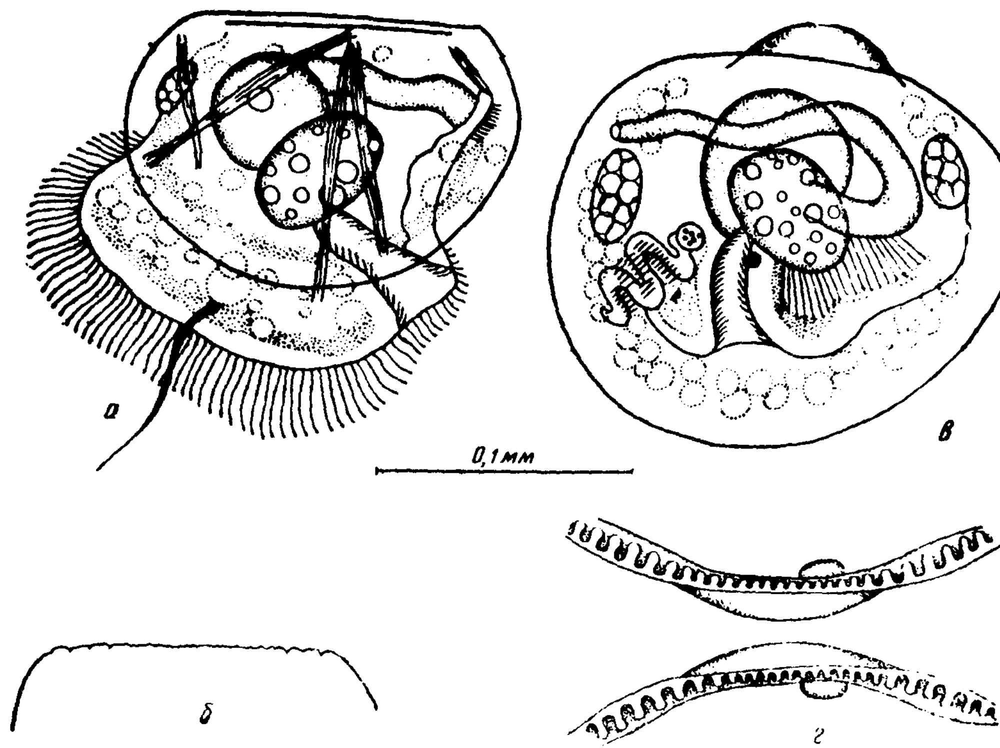


Рис. 3.


Рис. 4.



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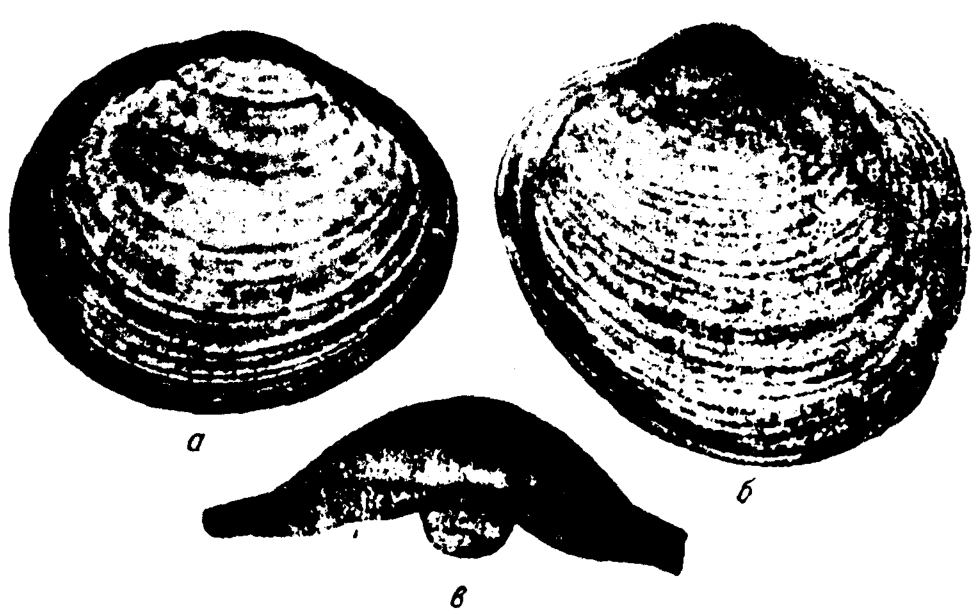

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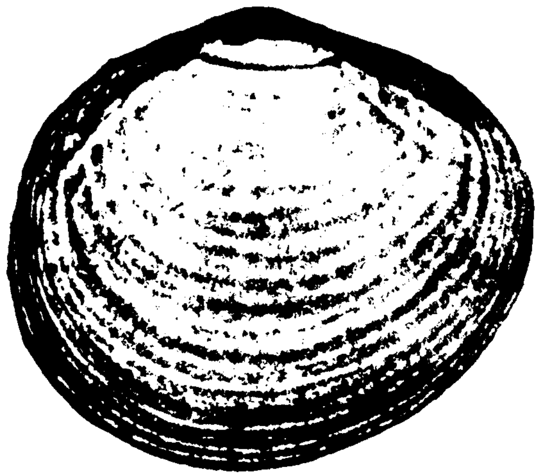

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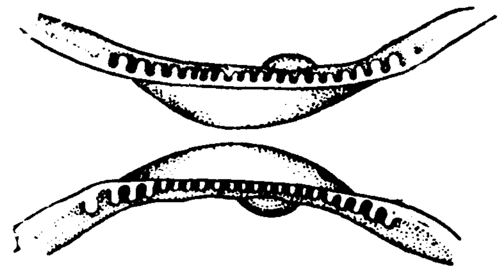

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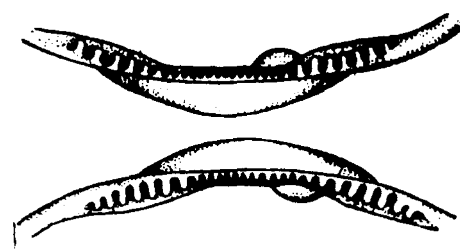

Рис. 10.

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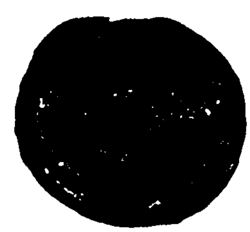
Рис. 9.



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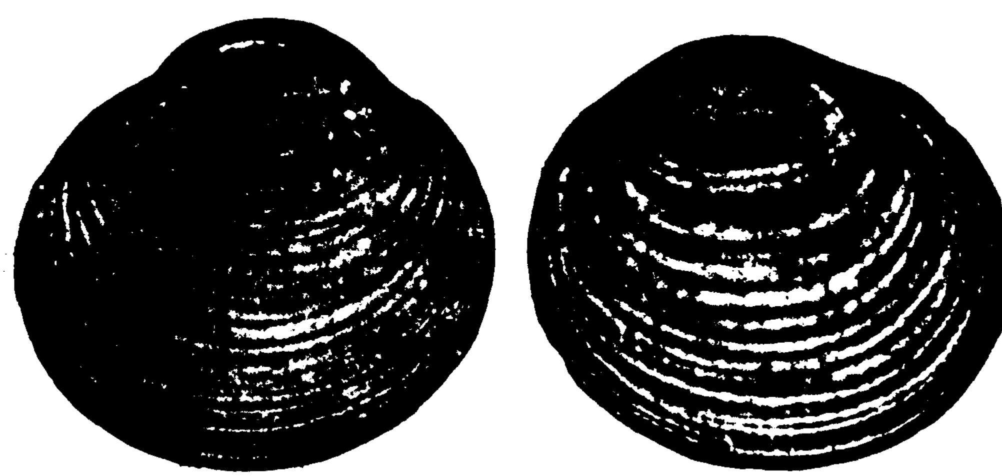

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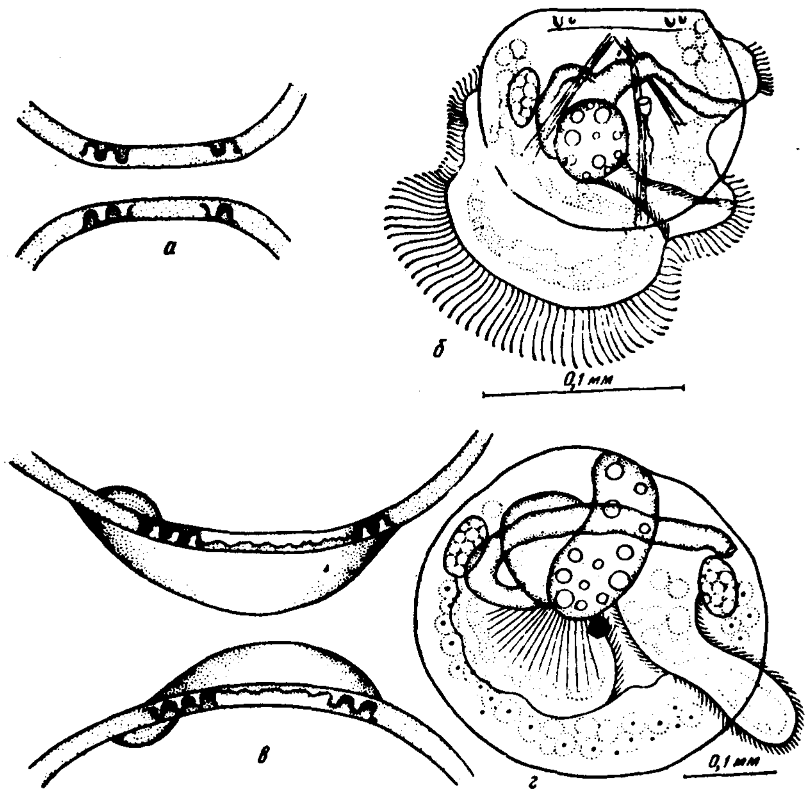

Рис. 12.

Рис. 13

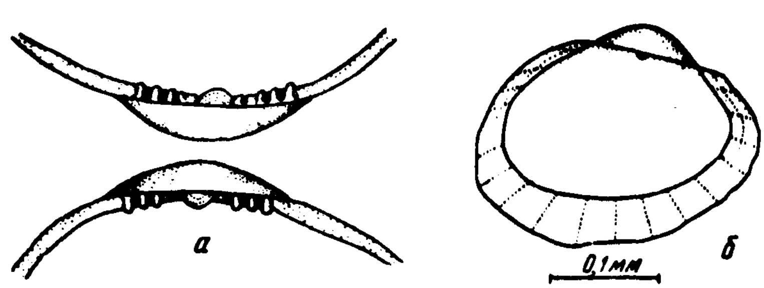

Рис. 14.

Рис. 15

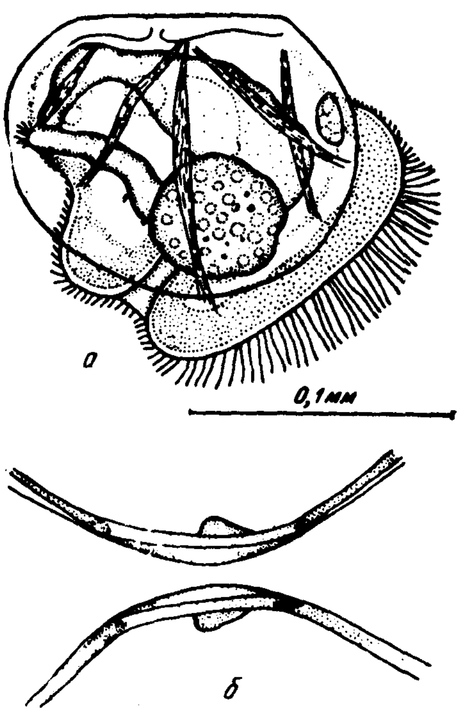

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Рис. 17.

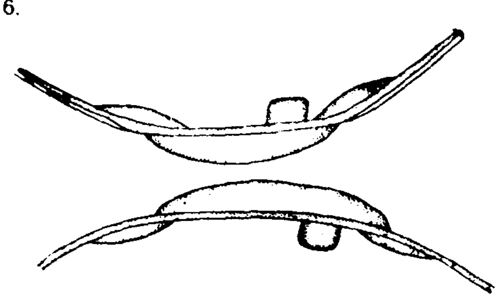
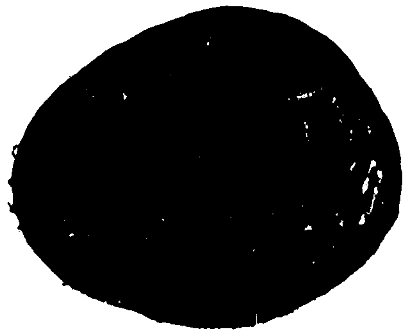


Рис. 18

Рис. 19.



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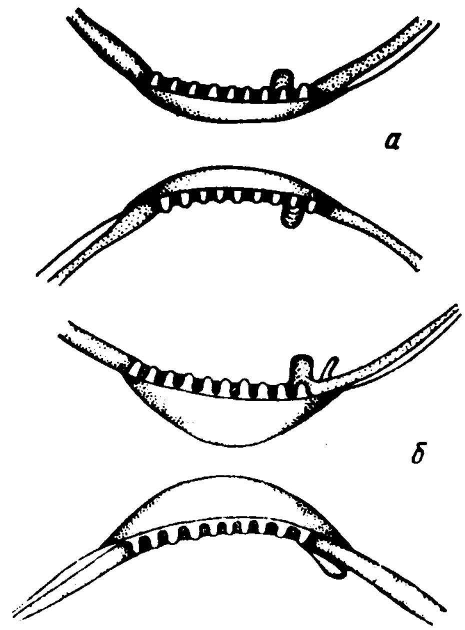

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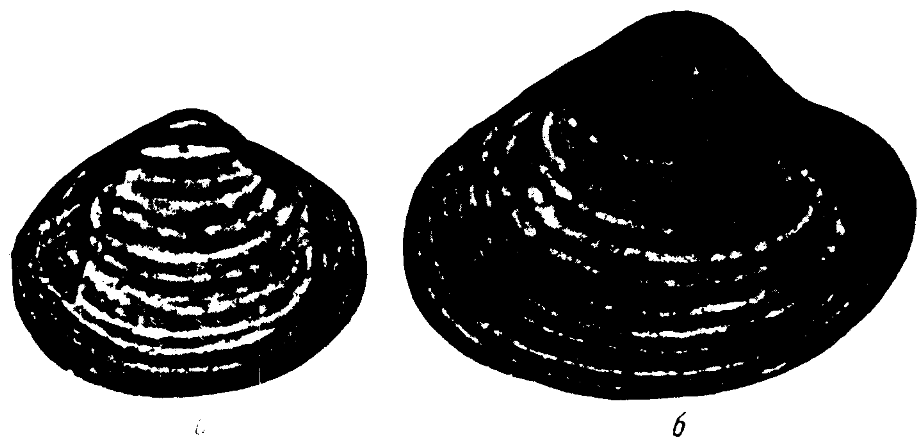

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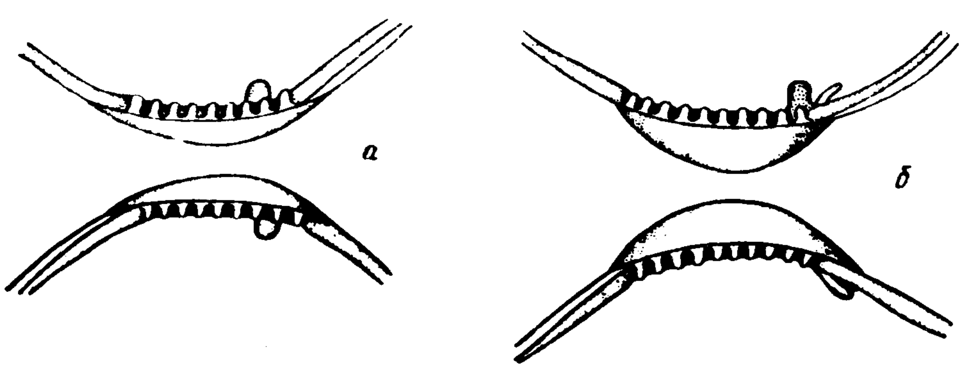

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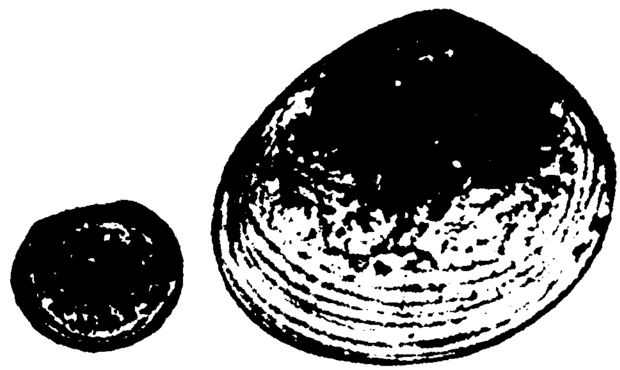

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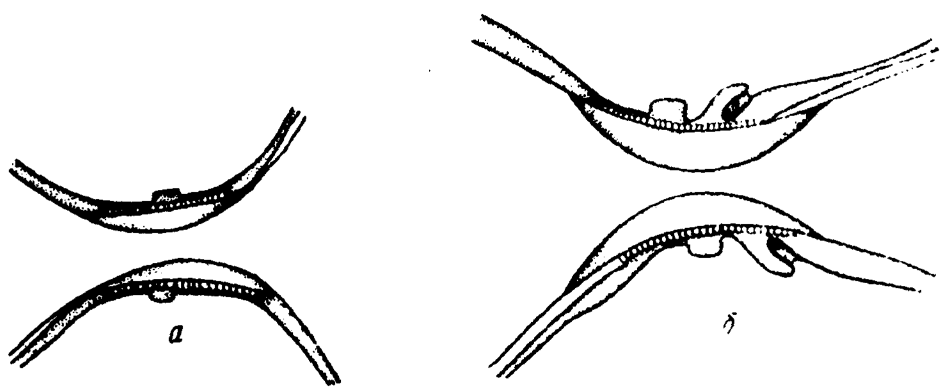

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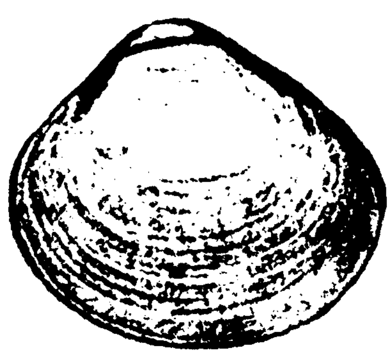

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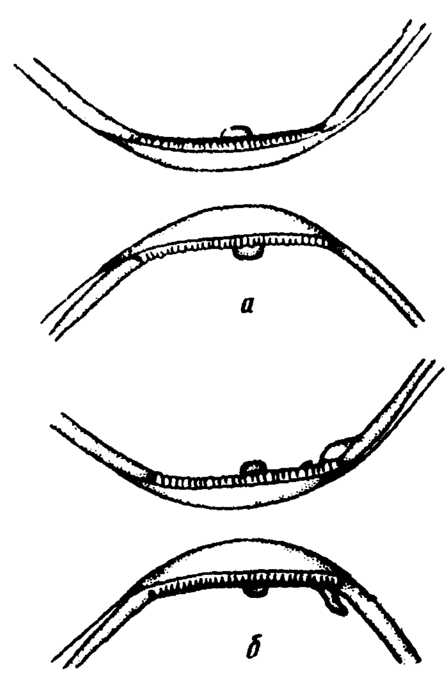

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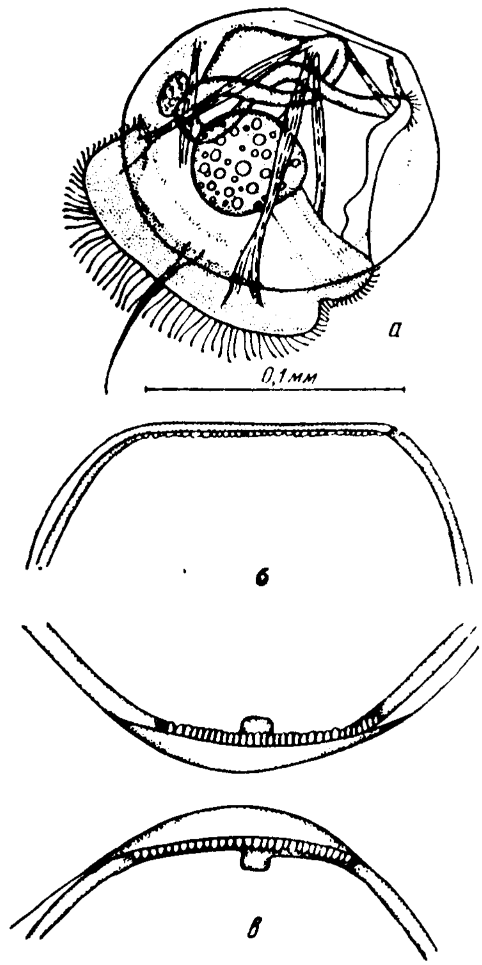

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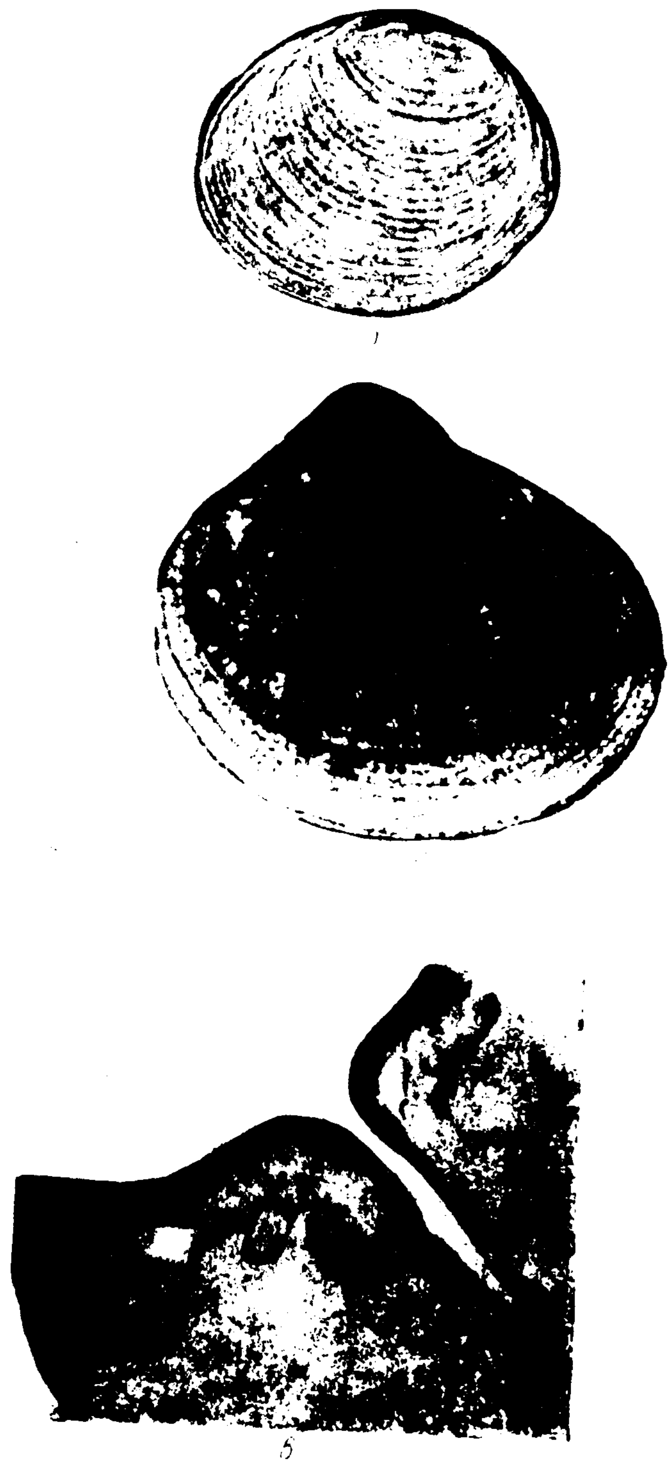

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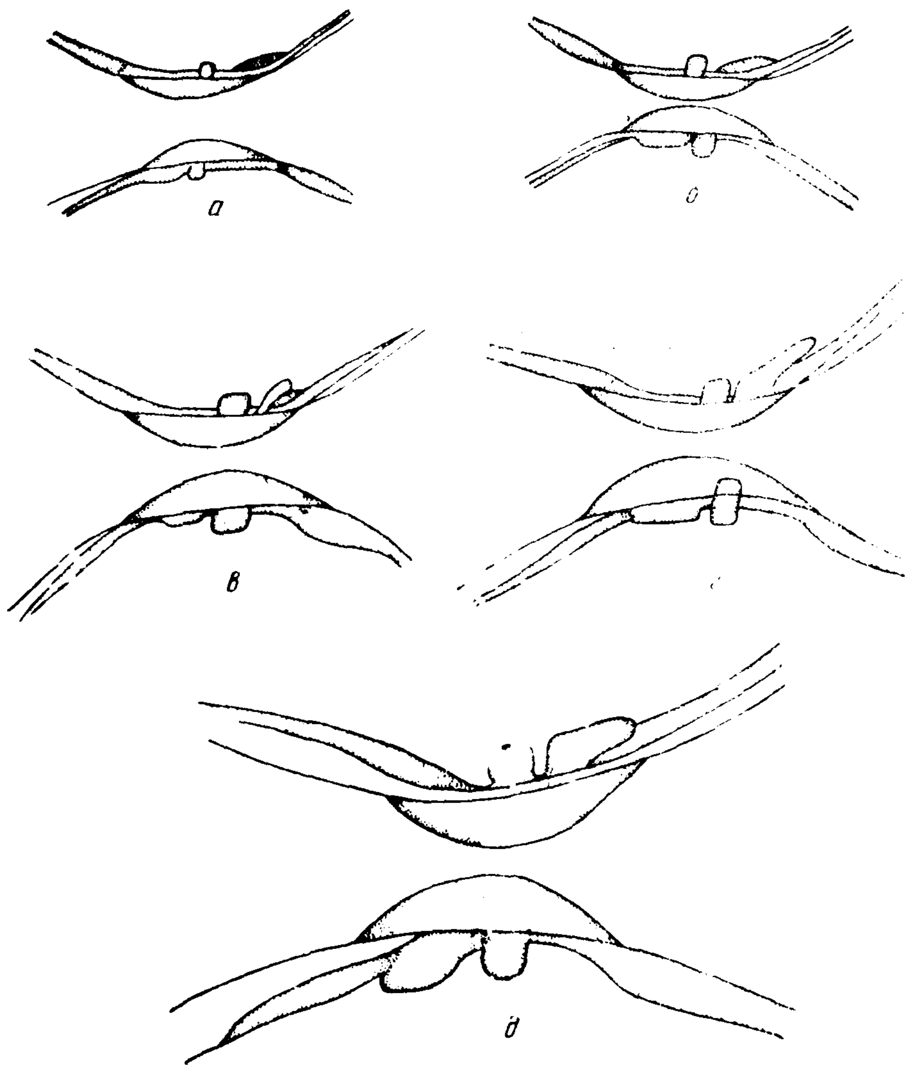

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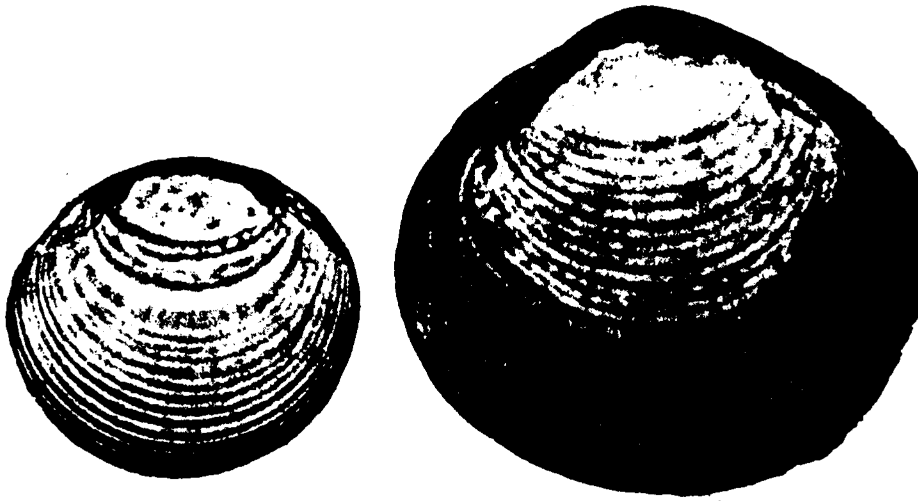

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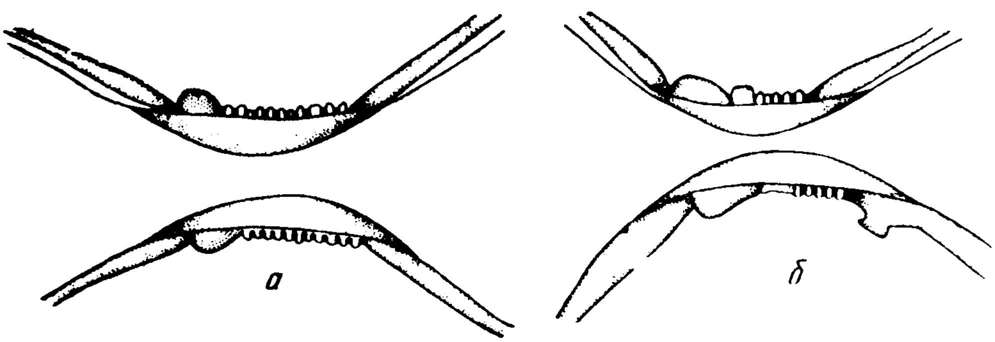

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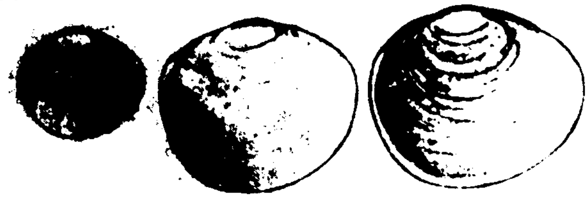

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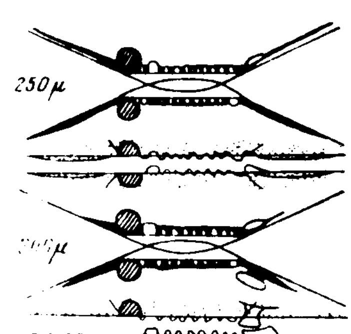

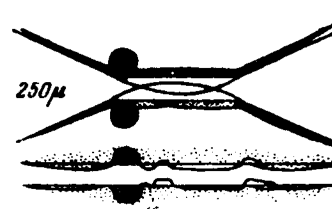

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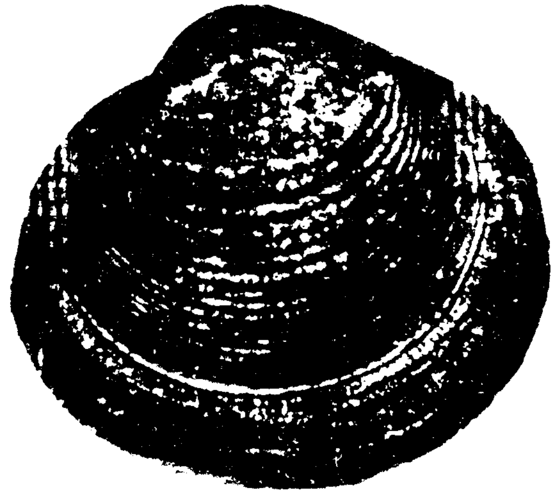

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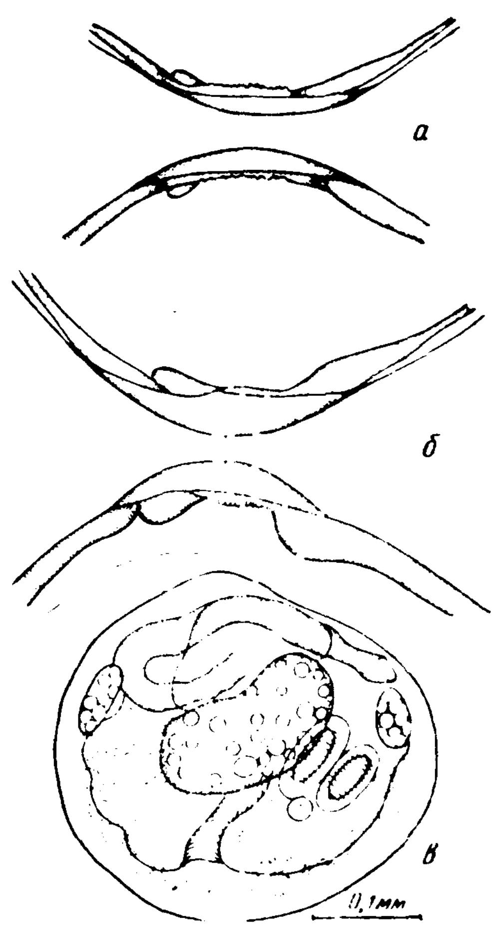

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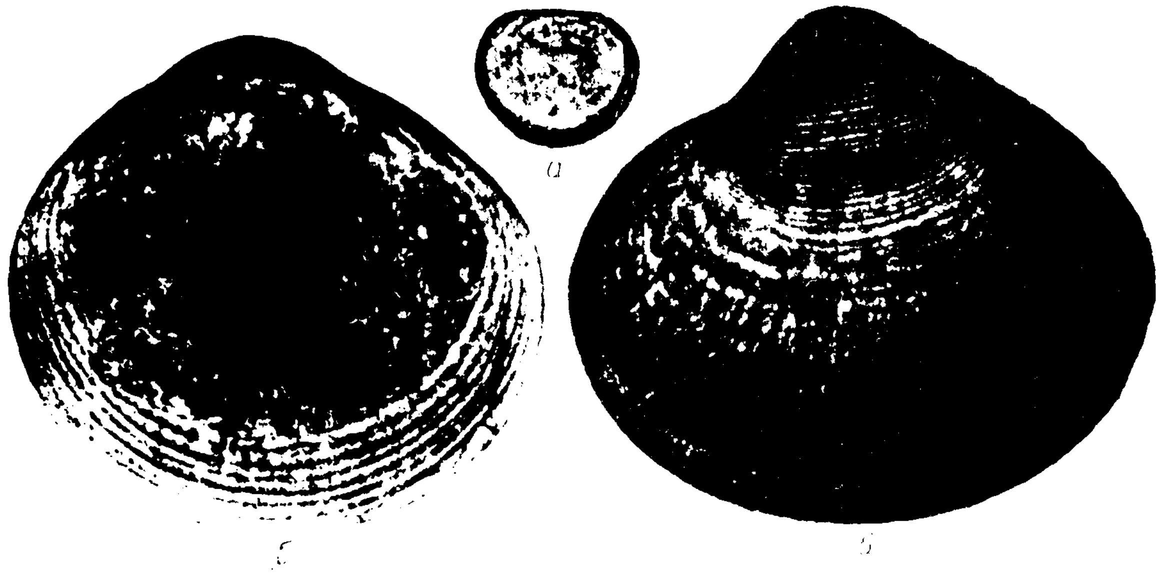

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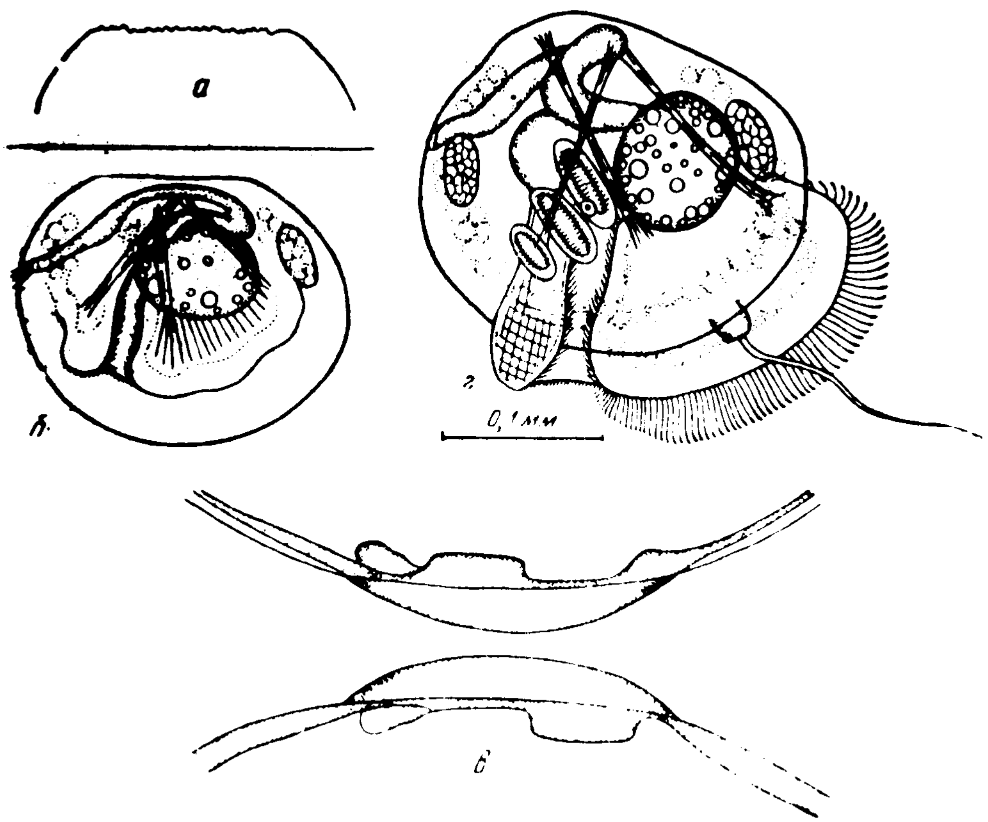

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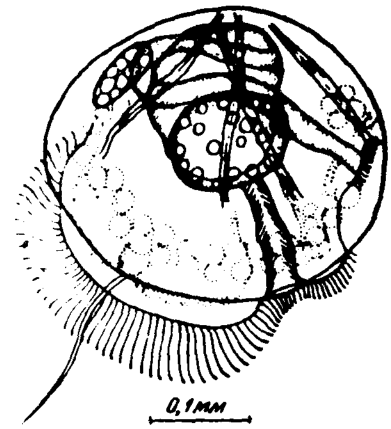

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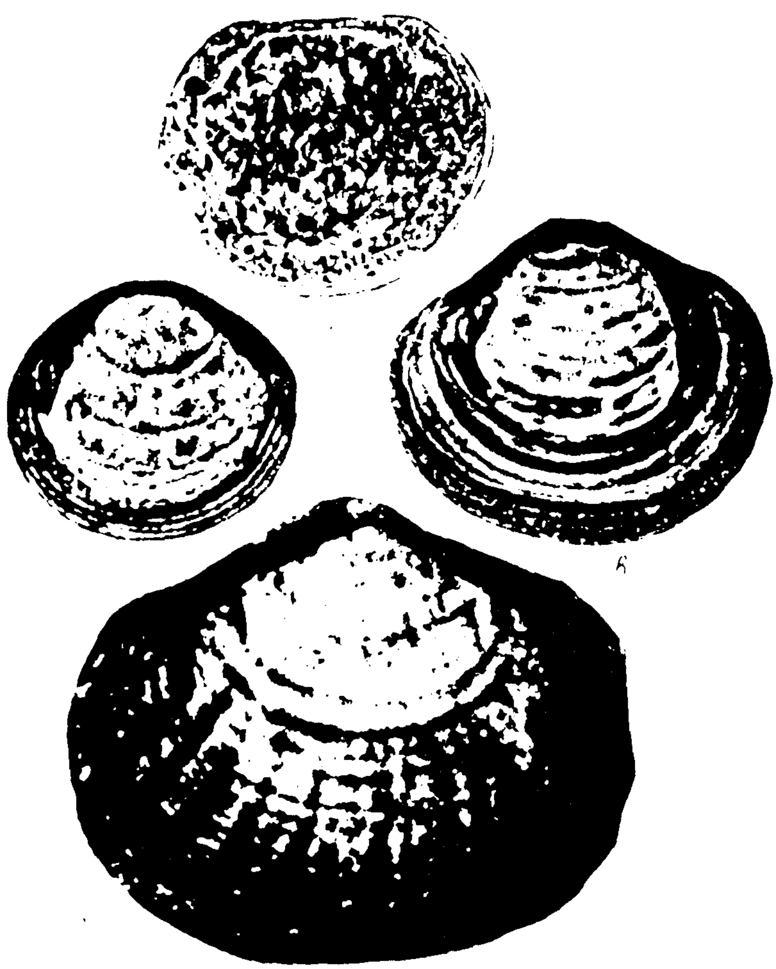

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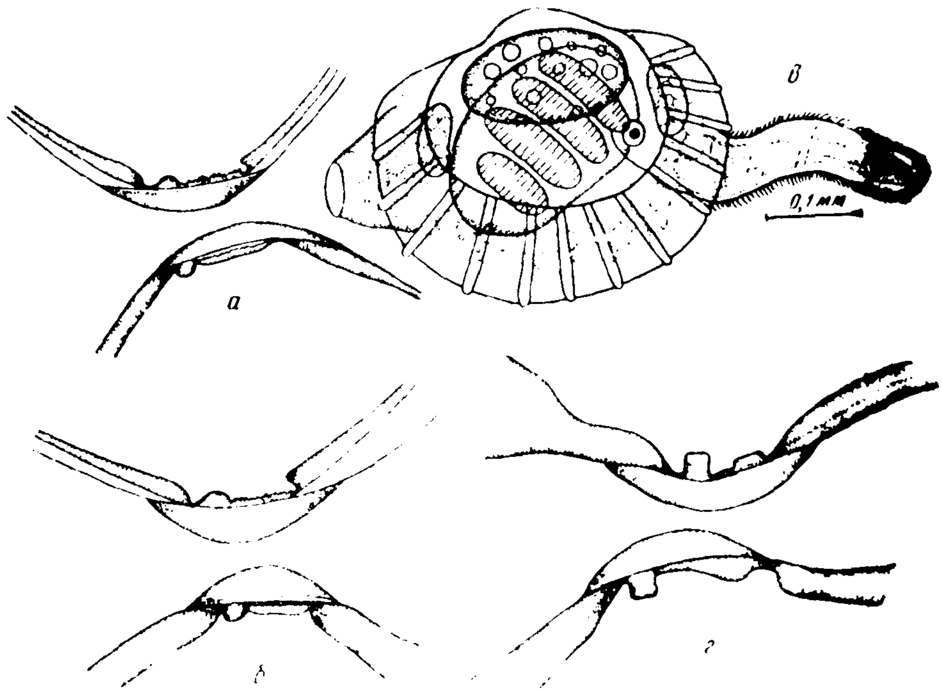

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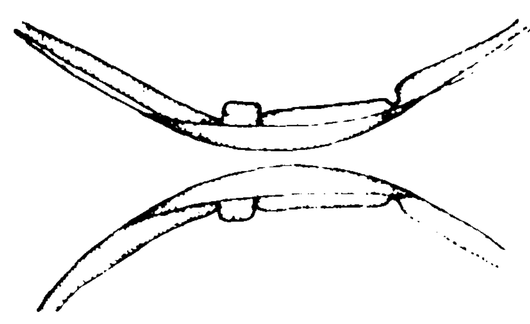

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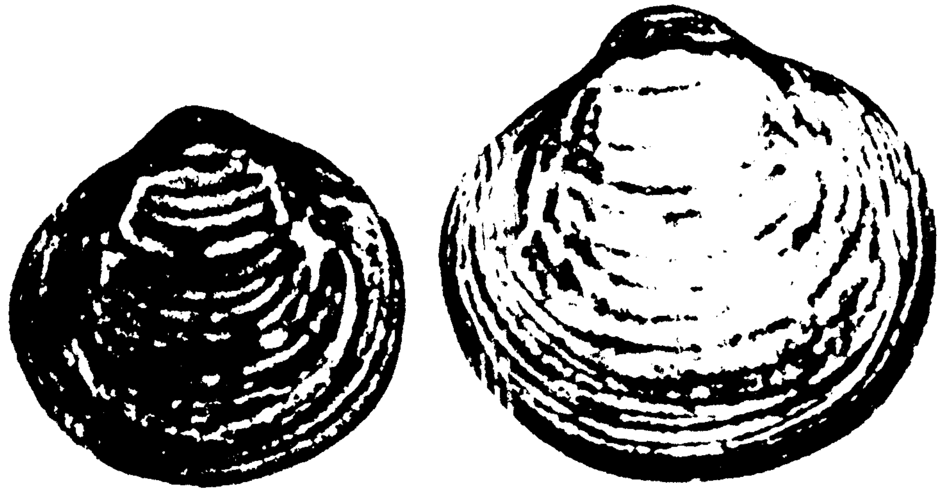

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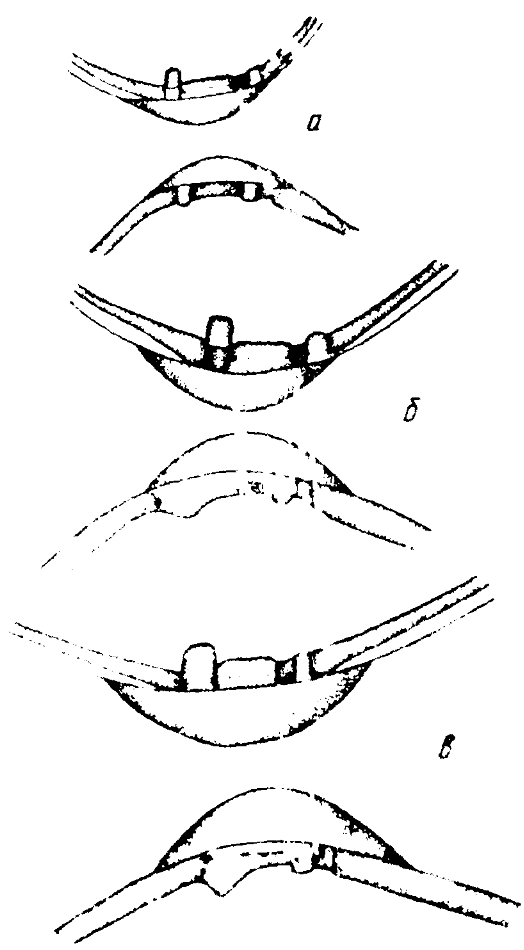

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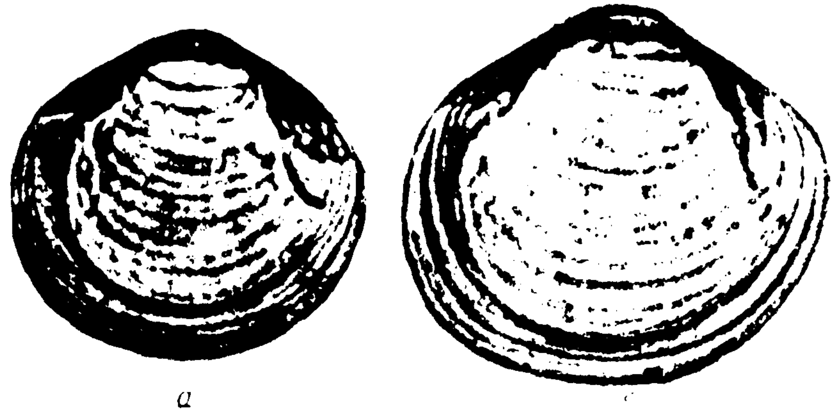

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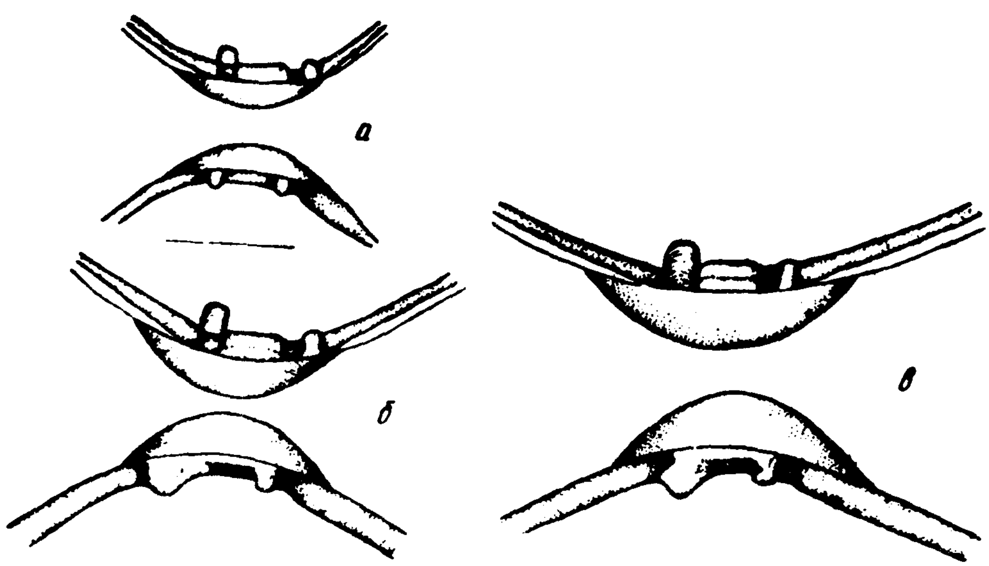

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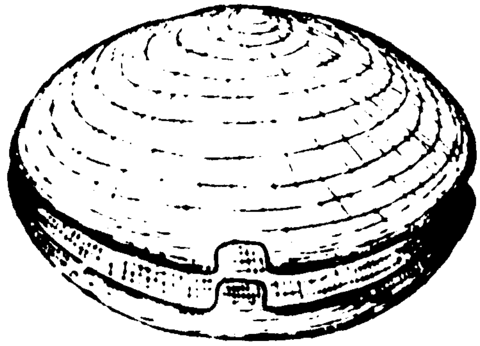

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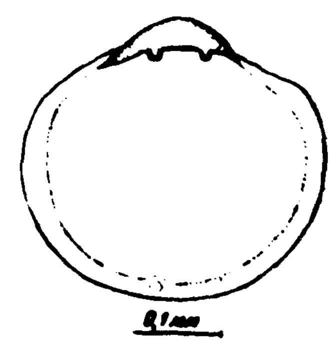

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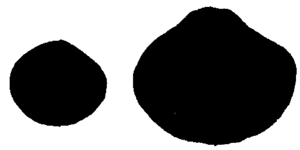

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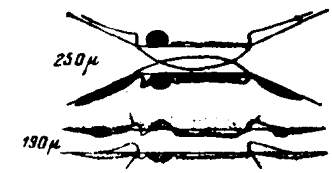

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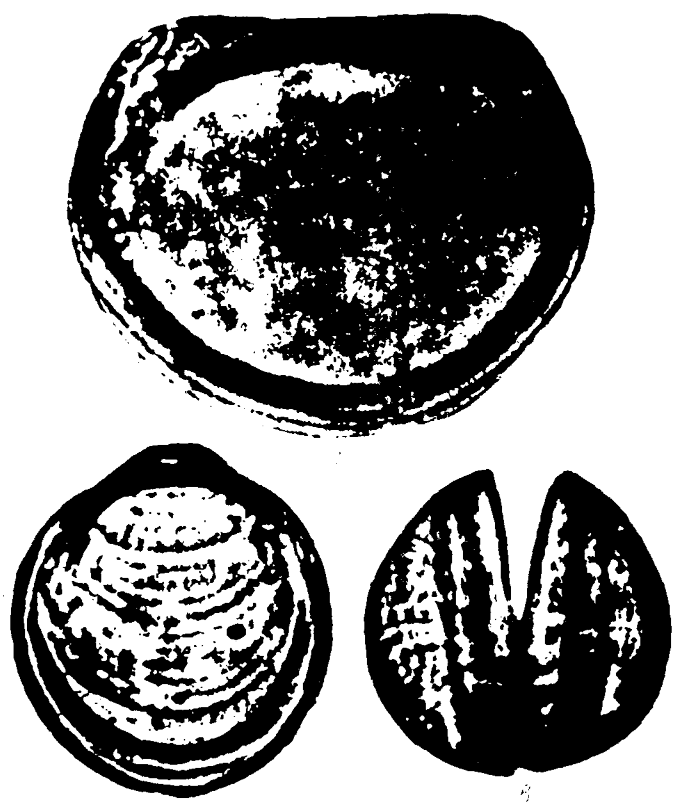

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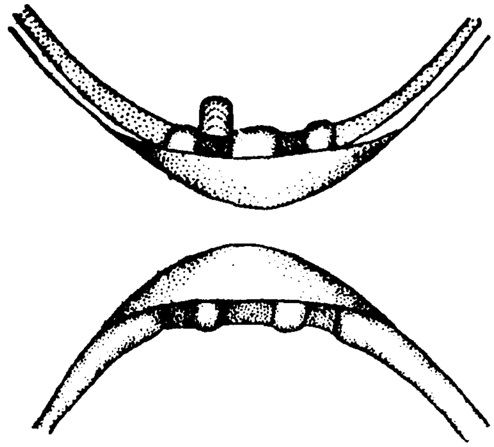

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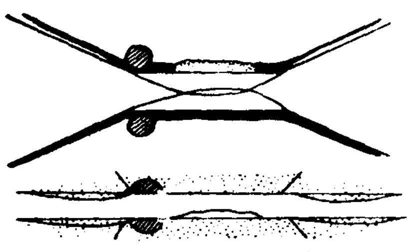

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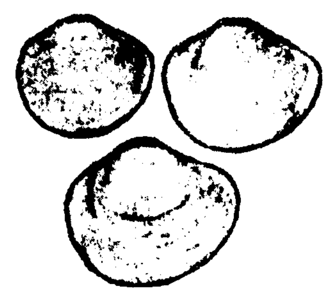

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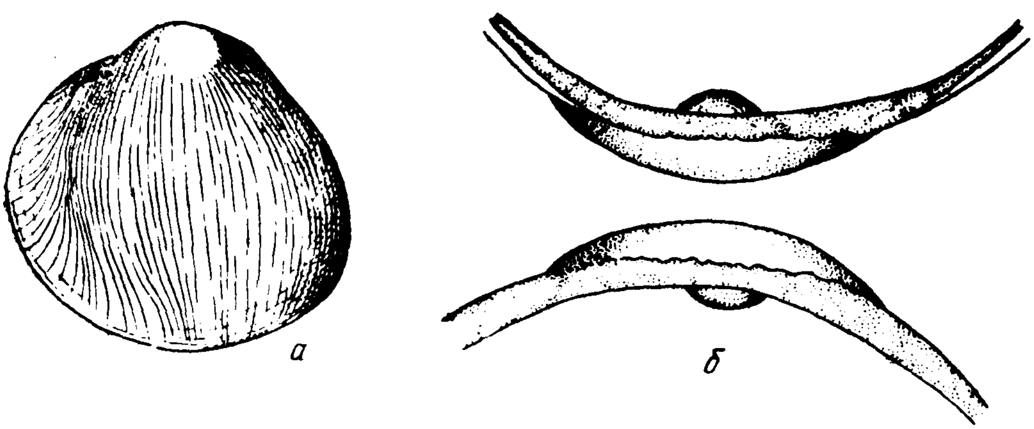

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Рис. 59.